

Project Manual



LEE'S SUMMIT
MEDICAL CENTER

Lee's Summit Medical Center ICU Expansion

2100 SE Blue Parkway
Lee's Summit, Missouri

Volume 1 of 2 (Divisions 00 thru 14)

January 14, 2022

ACIB Project #3-21112



Lee's Summit Medical Center - ICU Expansion ACIB Project No. 3-21112
01-17-2022

**SECTION 00 01 01
PROJECT TITLE PAGE**

PROJECT MANUAL

FOR

3-21112 HCA LSMC ICU EXPANSION

HCA MIDWEST

DATE: 01/14/2022

PREPARED BY:

ACI / BOLAND INC.

END OF SECTION 00 01 01

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**SECTION 00 01 02
PROJECT INFORMATION**

PART 1 GENERAL

1.01 PROJECT IDENTIFICATION

- A. Project Name: 3-21112 HCA LSMC ICU Expansion, located at: 2100 SE Blue Parkway, Lee's Summit, Missouri 64063.
Project Location Address 1.
Project Location City, Project Location StateProject Location ZIP.
- B. The Owner, hereinafter referred to as Owner: HCA Midwest
- C. Owner's Project Manager: Architect.

1.02 NOTICE TO PROSPECTIVE BIDDERS

- A. These documents constitute an Invitation to Bid to and request for qualifications from General Contractors for the construction of the project described below.

1.03 PROJECT DESCRIPTION

- A. Summary Project Description: ICU Expansion.

1.04 PROJECT CONSULTANTS

- A. The Architect, hereinafter referred to as Architect: ACI Boland.

1.05 PROCUREMENT TIMETABLE

- A. Last Request for Substitution Due: 7 days prior to due date of bids.
- B. Last Request for Information Due: 7 days prior to due date of bids.
- C. Bid Due Date: February 7, 2022, before 4 PM local time.
- D. Bid Opening: held privately.
- E. Notice to Proceed: Within 7 days after due date.
- F. The Owner reserves the right to change the schedule or terminate the entire procurement process at any time.

1.06 PRE-QUALIFIED BIDDERS

- A. Those already qualified to submit bids are:
 - 1. General Contractor: JE Dunn Construction.
 - 2. General Contractor: Lytle Construction.
 - 3. General Contractor: StructSure.

1.07 PROCUREMENT DOCUMENTS

- A. Documents may be viewed via supplied PDFs to select bidders and prequalified subcontractors.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 00 01 02

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SECTION 00 01 06
DISCLAIMER - STRUCTURAL

I HEREBY STATE THAT ALL DOCUMENTS INTENDED TO BE AUTHENTICATED BY MY SEAL ARE LIMITED TO:

PROJECT MANUAL:

03 30 00	05 12 00	05 31 00	05 40 00	05 50 00

NOTE: Divisions listed include all sections listed in Table of Contents for that Division.

DRAWINGS:

S0.1	S1.0	S1.1	S2.0	S3.0
S3.1				

I HEREBY DISCLAIM ANY RESPONSIBILITY FOR ALL OTHER SPECIFICATIONS, ESTIMATES, REPORTS OR OTHER DOCUMENTS OR INSTRUMENTS RELATED TO OR INTENDED TO BE USED FOR ANY PART OR PARTS OF THIS ARCHITECTURAL PROJECT.

SEAL:



Date: January 14, 2022

Name: Jeffrey L. Wright
State / Registration No.: Missouri/PE-2005026803
Discipline: Structural Engineering
Title: Principal
Company : Bob D. Campbell & Company

DISCLAIMER OF RESPONSIBILITY

Mechanical Engineer

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Jacob Katzenberger P.E. MO 2017038594
Henderson Engineers, Inc.
Mechanical Engineer

Date

SEAL:



01/14/2022

DISCLAIMER OF RESPONSIBILITY

Plumbing Engineer

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Jacob Katzenberger P.E. MO 2017038594
Henderson Engineers, Inc.
Plumbing Engineer

Date

SEAL:



01/14/2022

DISCLAIMER OF RESPONSIBILITY

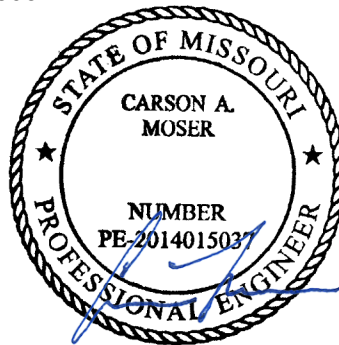
Electrical Engineer

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Carson Moser, P.E. MO 2014015037
Henderson Engineers, Inc.
Electrical Engineer

Date

SEAL:



01/14/2022

DISCLAIMER OF RESPONSIBILITY

Fire Protection Engineer

I HEREBY STATE THAT ALL DOCUMENTS INTENDED TO BE AUTHENTICATED BY MY SEAL ARE LIMITED TO SPECIFICATION SECTIONS 210010, 210500, 210515, 210548, 210553, 211313, 284600 AND DRAWINGS FX0.0, FX1.1, FXD1.1 AND HEREBY DISCLAIM ANY RESPONSIBILITY FOR ALL OTHER SPECIFICATIONS, ESTIMATES, REPORTS OR OTHER DOCUMENTS OR INSTRUMENTS RELATING TO OR INTENDED TO BE USED FOR ANY PART OR PARTS OF THE ARCHITECTURAL OR ENGINEERING PROJECT OR SURVEY.

Mark Chrisman P.E. MO 2018036637
Henderson Engineers, Inc.
Fire Protection Engineer

Date

SEAL:



01/14/2022

**SECTION 00 01 10
TABLE OF CONTENTS**

PROJECT MANUAL - VOLUME NO. 1

DIVISION 00 -- PROCUREMENT AND CONTRACTING REQUIREMENTS

- 00 00 00 - Cover
- 00 00 02 - Project Title Page
- 00 00 04 - Arch Disclaimer
- 00 00 05 - Civil Disclaimer
- 00 00 06 - Structural Disclaimer
- 00 00 07 - Mechanical Disclaimer
- 00 00 08 - Electrical Disclaimer
- 00 00 09 - Plumbing Disclaimer
- 00 01 02 - Project Information
- 00 01 10 - Table of Contents
- 00 01 15 - List of Drawing Sheets
- 00 11 13 - Invitation to Bid
- 00 21 13 - Instructions to Bidders
- 00 21 22 - Select Bidders List
- 00 41 00 - Bid Form

DIVISION 01 -- GENERAL REQUIREMENTS

- 01 10 00 - Summary
- 01 20 00 - Price, Payment, and Contract Modification Procedures
- 01 25 00 - Substitution Procedures
- 01 30 00 - Administrative Requirements
- 01 33 00 - Submittal Procedures
- 01 40 00 - Quality Requirements
- 01 45 33 - Code-Required Special Inspections and Procedures
- 01 50 00 - Temporary Facilities and Controls
- 01 60 00 - Product Requirements
- 01 78 00 - Closeout Submittals
- 01 79 00 - Demonstration and Training
- 01 91 13 - General Commissioning Requirements

DIVISION 02 -- EXISTING CONDITIONS

- 02 41 00 - Selective Demolition

DIVISION 03 -- CONCRETE

- 03 30 00 - Cast-in-Place Concrete
- 03 30 30 - Concrete Work - Patching

DIVISION 04 -- MASONRY

- 04 20 00 - Brick and Concrete Masonry (Full Scope)

DIVISION 05 -- METALS

- 05 12 00 - Structural Steel Framing
- 05 31 00 - Steel Decking
- 05 40 00 - Cold-Formed Metal Framing
- 05 50 00 - Metal Fabrications

DIVISION 06 -- WOOD, PLASTICS, AND COMPOSITES

- 06 10 00 - Rough Carpentry
- 06 16 00 - Glass-Mat Gypsum Sheathing
- 06 61 16 - Solid Surface Fabrication
- 06 82 00 - Rigid Sheet Wall Protection Panels

DIVISION 07 -- THERMAL AND MOISTURE PROTECTION

- 07 14 00 - Fluid-Applied Waterproofing
- 07 21 00 - Thermal Insulation
- 07 24 00 - Exterior Insulation and Finish Systems (Dryvit)
- 07 27 26 - Fluid-Applied Vapor-Permeable Membrane Air Barriers
- 07 54 23 - TPO Single-Ply Roofing System
- 07 62 00 - Sheet Metal Flashing and Trim
- 07 72 00 - Roof Accessories
- 07 81 00 - Applied Fire Protection
- 07 84 00 - Penetration Firestopping
- 07 92 00 - Joint Sealants
- 07 95 13 - Expansion Joint Cover Assemblies

DIVISION 08 -- OPENINGS

- 08 12 13 - Hollow Metal Frames for Wood Doors
- 08 14 16 - Flush Wood Veneer Doors
- 08 31 00 - Access Doors and Panels
- 08 43 13 - Aluminum-Framed Entrances and Storefronts (Kawneer)
- 08 71 00 - Door Hardware
- 08 80 00 - Glazing

DIVISION 09 -- FINISHES

- 09 05 61 - Common Work Results for Flooring Preparation
- 09 21 16 - Gypsum Board Assemblies
- 09 22 16 - Non-Structural Metal Framing
- 09 51 00 - Acoustical Ceilings
- 09 65 00 - Resilient Flooring
- 09 65 13 - Resilient Base and Accessories
- 09 68 13 - Tile Carpeting
- 09 91 23 - Interior Painting

DIVISION 10 -- SPECIALTIES

- 10 26 13 - Wall Protection Panels and Corner Guards
- 10 28 00 - Toilet Accessories

10 44 00 - Fire Protection Specialties (JL Industries / Larsen's)

10 51 00 - Metal Lockers

DIVISION 12 -- FURNISHINGS

12 32 16 - Manufactured Plastic Laminate Faced Casework

PROJECT MANUAL - VOLUME 2

2.01 DIVISION 21 -- FIRE SUPPRESSION

21 00 10 - General Fire Suppression Requirements

21 05 00 - Common Work Results for Fire Suppression

21 05 15 - Basic Fire Suppression Piping Methods and Materials

21 05 48 - Seismic Controls for Fire Suppression

21 13 13 - Water Based Fire Suppression Systems

2.02 DIVISION 22 -- PLUMBING

22 00 10 - General Plumbing Requirements

22 00 15 - Coordination

22 05 00 - Common Work Results for Plumbing.

22 05 15 - Basic Piping Materials and Methods

22 05 16 - Expansion Fittings and Loops for Plumbing Piping

22 05 23 - General-Duty Valves for Plumbing Piping

22 05 29 - Hangers and Supports for Plumbing Piping

22 05 53 - Identification for Plumbing Piping and Equipment

22 07 00 - Plumbing Insulation

22 11 00 - Water Distribution Piping and Specialties

22 13 00 - Sanitary Drainage and Vent Piping and Specialties

22 14 00 - Storm Drainage Piping and Specialties

22 40 00 - Plumbing Fixtures

22 61 13 - Gas and Vacuum Systems for Healthcare Facilities

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

A. 23 00 10 - General Mechanical Requirements

23 05 19 - Meters and Gauges for HVAC Piping

23 05 23 - General-Duty Valves for HVAC Piping

23 05 29 - Hangers and Supports for HVAC Piping and Equipment

23 05 53 - Identification for HVAC Piping and Equipment

23 05 93 - Testing, Adjusting, and Balancing for HVAC

23 07 00 - HVAC Insulation

23 08 00 - Commissioning of HVAC Systems

23 09 13 - Instrumentation and Control Devices for HVAC

23 09 23 - Direct-Digital Control System for HVAC

23 21 13 - Hydronic Piping

B. 23 21 16 - Hydronic Specialties

23 22 13 - Steam and Condensate Heating Piping

23 22 16 - Steam and Condensate Heating Specialties

- C. 23 31 13 - Metal Ducts
 - 23 33 00 - Air Duct Accessories
 - 23 34 23 - HVAC Power Ventilators
 - 23 36 00 - Air Terminal Units
 - 23 37 13 - Diffusers, Register, and Grilles
 - 23 74 13 - Packaged Outdoor Central-Station Air-Handling Units
 - 23 84 13 - Humidifiers (Dispersion Type)

DIVISION 26 -- ELECTRICAL

- 26 00 10 - General Electrical Requirements
- D. 26 00 15 - Electrical Materials Purchasing
 - 26 05 00 - Common Work Results for Electrical
- E. 26 05 02 - Equipment Wiring Systems
 - 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
 - 26 05 26 - Grounding and Bonding for Electrical Systems
- F. 26 05 29 - Hangers and Supports for Electrical Systems
 - 26 05 33 - Raceway and Boxes for Electrical Systems
 - 26 05 43 - Underground Ducts and Raceways for Electrical Systems
 - 26 05 53 - Identification for Electrical Systems
 - 26 05 73 - Overcurrent Protective Device Coordination Study
- G. 26 09 23 - Lighting Control Devices
 - 26 22 00 - Low-Voltage Transformers
 - 26 24 16 - Panelboards
 - 26 27 26 - Wiring Devices
 - 26 28 13 - Fuses
- H. 26 43 13 - Surge Protective Device
- I. 26 51 00 - Interior Lighting
 - 26 56 00 - Exterior Lighting

DIVISION 28 -- ELECTRONIC SAFETY AND SECURITY

- 28 46 00 - Fire Detection and Alarm

END OF SECTION 00 01 10

**SECTION 00 01 15
LIST OF DRAWING SHEETS**

GENERAL

- A0.1 COVER SHEET**
- A0.2 CODE FOOTPRINT PLAN**
- A0.3 PARTITION TYPES AND DETAILS**
- A0.4 U.L. DESIGN ASSEMBLIES**
- A0.5 GENERAL NOTES, LEGENDS & SYMBOLS**

CIVIL

- C1.0 DEMOLITION PLAN**
- C2.0 GRADING/UTILITY PLAN**
- C3.0 CONSTRUCTION DETAILS**
- C4.0 EROSION CONTROL DETAILS**

DEMOLITION

- AD2.1 DEMOLITION PLAN**

ARCHITECTURE

- A2.1 FIRST FLOOR DIMENSION PLAN**
- A2.2 FIRST FLOOR ANNOTATION PLAN**
- A2.4 PLAN DETAILS**
- A2.5 ROOF PLAN AND DETAILS**
- A3.1 FIRST FLOOR REFLECTED CEILING PLAN**
- A4.1 DOOR AND FRAME SCHEDULE AND DETAILS**
- A4.2 ROOM FINISH SCHEDULE & FINISH LEGEND**
- A5.1 EXTERIOR ELEVATIONS**

A6.2 WALL SECTIONS AND DETAILS

A7.1 INTERIOR ELEVATIONS

A7.2 INTERIOR DETAILS

A7.3 INTERIOR DETAILS

STRUCTURAL

S0.1 GENERAL NOTES

S1.0 FOUNDATION PLAN & ROOF FRAMING PLAN

S1.1 BRACE ELEVATIONS & DETAILS

S2.0 FOUNDATION SECTIONS

S3.0 FRAMING SECTIONS

S3.1 FRAMING SECTIONS

MECHANICAL

M0.0 MECHANICAL GENERAL NOTES AND LEGEND

MD1.1 HVAC FIRST FLOOR DEMOLITION PLAN

M1.1 HVAC FIRST FLOOR PLAN

M2.1 PIPING FIRST FLOOR PLAN

M3.1 MECHANICAL ROOF PLAN

M4.0 MECHANICAL SCHEDULES

M4.1 MECHANICAL CONTROLS

M4.2 MECHANICAL CONTROLS

M5.0 MECHANICAL DETAILS

M5.1 MECHANICAL DETAILS

PLUMBING

P0.0 PLUMBING GENERAL NOTES AND LEGEND

PD1.1 PLUMBING FIRST FLOOR DEMOLITION PLAN

P1.1 PLUMBING WASTE & VENT FIRST FLOOR PLAN

P2.1 PLUMBING WATER FIRST FLOOR PLAN

P3.1 PLUMBING MEDICAL GAS FIRST FLOOR PLAN

P4.1 PLUMBING ROOF PLAN

P5.0 PLUMBING SCHEDULES AND DETAILS

ELECTRICAL

E0.0 ELECTRICAL GENERAL NOTES AND LEGEND

ED1.1 LIGHTING FIRST FLOOR DEMOLITION PLAN

ED2.1 POWER FIRST FLOOR DEMOLITION PLAN

E1.1 LIGHTING FIRST FLOOR PLAN

E2.1 POWER FIRST FLOOR PLAN

E3.1 EQUIPMENT CONNECTION FIRST FLOOR PLAN

Lee's Summit Medical Center - ICU Expansion ACIB Project No. 3-21112
01-17-2022

E3.2 EQUIPMENT CONNECTION ROOF PLAN
E4.1 SPECIAL SYSTEMS FIRST FLOOR PLAN
E5.0 ELECTRICAL ONE-LINE DIAGRAM
E6.0 ELECTRICAL SCHEDULES
E6.1 ELECTRICAL PANEL SCHEDULES
E7.0 ELECTRICAL DETAILS

FIRE PROTECTION

FX0.0 FIRE PROTECTION GENERAL NOTES AND LEGEND
FXD1.1 FIRE PROTECTION FIRST FLOOR DEMOLITION PLAN
FX1.1 FIRE PROTECTION FIRST FLOOR PLAN

END OF SECTION 00 01 15

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HCA Lee's Summit Medical Center ICU Expansion

Lee's Summit, Missouri
ACI/Boland Project # 3-21112

INVITATION TO BID

Ladies and Gentlemen:

Your firm has been placed on a Select List of Bidders and you are invited to submit a Bid for construction of the ICU Expansion at HCA Lee's Summit Medical Center in accordance with the drawings and project manual and other Contract Documents as prepared by ACI/Boland, Inc.

Sealed Bids will be received at the office of or **via email** to ACI-Boland, Inc. on behalf of HCA LSMC; Attn: Keith Crane, Architect; 1710 Wyandotte St. Kansas City, MO 64108.

Bids are due at 4:00 P.M., February 7th, 2022, for the General Construction of the above described project.

The bids will be privately opened and the results will not be published.

Contract Drawings and Project Manuals will be made available to the following pre-selected Contractors via email.

All pre-selected Subcontractor's bids will be due 24 hours prior to General Construction Bid Due Time directly to each of the pre-selected General Contractors.

General Contractor's shall state in their proposal the length of time that will be required to complete this project. The Contract will be awarded within one week after the Bid Opening. However, the Owner reserves the right to reject any or all Bids and to waive any informality or technicality in Bidding if it be in the best interest to do so.

Contractors are invited to examine the building site and all existing conditions thereon, since the Proposal must take into consideration all such conditions as they may affect the work. **A Pre-bid walk-thru will be held at Lee's Summit Medical Center on January 25th, 2022, 4:00 p.m.**, at the main entrance lobby for all contractors and subcontractors bidding on this project to examine the area of work. This will be the one and only time to look at this space prior to bidding. Any questions arising from the walk-thru must be submitted to the Architect in writing for a clarification. Please park near the main entrance of the hospital parking lot. Due to current conditions, please bring as few team members as possible.

The Owner will award one (1) Contract for the General Construction, including the Plumbing, Heating, Ventilating and Air Conditioning and Electrical work based on the best value combined bid for this project. Refer to Instructions to Bidders for additional information.

Sincerely,

ACI/BOLAND, INC.

...

INSTRUCTIONS TO BIDDERS

I. GENERAL INFORMATION

1. The ICU Expansion for Lee's Summit Medical Center shall be bid as follows:

Proposals will be received for a Lump Sum Bid for the construction of this project.
2. Project Scope
 - a. Shall be as detailed on the Project Drawings and Manual.
3. Refer to Invitation to Bid for information relating to time, date, and place for receipt of Bid Proposals, and other pertinent bidding information.
4. Refer to the General Requirements for information relating to time for completion, liquidated damages, insurance, payment, guaranty bonds, taxes, substitution of materials, and other conditions pertinent to the work.
5. The form of the Contract Agreement, Performance Bond, and Labor and Material payment Bond shall follow AIA standard forms.
6. To be considered, Bids shall be made in accordance with the following instructions.

II. QUALIFICATION OF GENERAL CONTRACTORS

General Contractors have been pre-selected by the Owner.

Prior to Bidding all the Contractors indicated below have been pre-qualified. The Owner shall have the right to take such steps as it deems necessary to determine the ability of any Bidding Contractor, subcontractor and supplier and of that Bidder to perform the work. The Bidder shall furnish to the Owner all such information and data for this purpose, as he may request. The right is reserved to reject any Contractor and/or his Bid where investigation or consideration of the information submitted by such Contractors does not satisfy the Owner that the Bidder has previous experience in performing similar or comparable work, has sufficient business and technical organization, financial resources and plan available to be used in performing contemplated work.

General Contractors:

JEDunn Construction
Lytle Construction
StructSure

III. EXAMINATION OF BIDDING DOCUMENTS AND ADDENDA

1. Each approved Bidder shall carefully examine the Bidding Documents and all Addenda or other revisions, and thoroughly inform himself with all requirements prior to submitting a Bid. Should a Bidder find discrepancies or ambiguities in, or omission from Bidding Documents, or should he be in doubt as to their meaning, he shall at once and prior to bid date, notify the Architect, who will send written Addenda to all Bidders. The Architect will not be responsible for any oral instructions. All Addenda sent to Bidders will become a part of Contract Documents. All inquiries shall be directed to Architect's office; ACI/Boland, Inc., 1710 Wyandotte Street, Kansas City, Missouri 64108, Telephone 816.763.9600. No consideration will be granted for any alleged misunderstanding of the materials, articles, or pieces of equipment to be furnished or work to be done, it being

understood that the tender of a Bid Proposal carries with it the agreement to all items and conditions referred to herein or indicated in the Bidding Documents.

2. Changes or corrections may be made in the Bidding Documents after they have been issued and before bids are received. In such case, a written Addendum describing the change or correction will be issued by the Architect to all Bidders. Such Addendum or Addenda shall take precedence over the portion of the Bidding Documents concerned, and shall be considered as part of the Bidding Documents. Bidder shall acknowledge receipt of all Addenda on the Form of Proposal in the space provided.

IV. EXAMINATION OF CONDITIONS AFFECTING WORK

Prior to submitting a Bid, each Bidder shall examine and thoroughly familiarize himself with all existing conditions including all applicable laws, codes, ordinances, rules and regulations that will affect his work. Bidders shall visit the site, examine the grounds and all existing conditions, utilities, possible adjacent parking areas, and roads, and shall ascertain by reasonable means all conditions that will in any manner affect the work. Bidders shall ask the Architect for any additional information deemed necessary for them to be fully informed to as exactly what is to be expected prior to submitting a Bid. The drawings have been prepared on the basis of available information and inspections of the site, and represent an essentially accurate indication of the physical conditions at the site. This, however, will not relieve the Bidder of the necessity for fully informing himself as to existing physical conditions. Refer to Invitation to Bid for site visit time.

V. PREPARATION OF PROPOSALS

1. To be considered as eligible to submit a Bid, a Bidder must be legally licensed to operate under applicable Laws of Missouri. Envelopes containing Bids shall be opaque, sealed, and must be so presented that they may be easily identified as containing Proposal.
 - a. Bid for General Construction of:

State Name of Project as listed on Drawing Title Block
Name and Address of Bidder
2. Submit Proposal as a lump sum cost. The proposal shall include a schedule of values itemized based on the CSI 16 Division format. The proposal shall indicate the major subcontractor's that are to be contracted with for this project. Any exclusions must be clearly noted. Oral or telephone bids or modifications will not be considered. Telegraphic bids will not be considered, but modification by telegraph of bids already submitted will be considered if received prior to the time set for receiving bids; telegraphic modifications shall not reveal the amount of the original or revised proposal. All blank spaces on the form must be filled-in. Signature must be in longhand and be executed by a Principal duly authorized to make contracts. Bidder's legal name must be fully stated. Completed forms must be without interlineation, alterations, or erasure. No bids will be considered after calling of time, regardless of how they are transmitted. Bids shall not contain any added statement that will recapitulate, modify, or interpret the terms of the Bid. All proposals must be notarized, and state if the Bidder is an individual, partnership or corporation.
3. Bids may not be withdrawn for a period of thirty (30) days after opening of Bids, except by mutual consent of Owner and Bidder, and except that Proposals may be withdrawn on written or telegraphic request received from Bidders prior to time fixed for receiving proposals. Negligence on the part of Bidders in preparing Bids confers no right for the withdrawal of Proposals after opening.
4. Proposals shall be submitted in triplicate inside one (1) envelope or via email.

VI. PERFORMANCE BOND, LABOR AND MATERIAL PAYMENT BOND AND INSURANCE:

1. The Bidder to whom the award is made will be required to furnish Performance and Labor and Material Payment Bonds in accordance with the General Conditions. The Bidder shall deliver said bonds to the Owner within ten (10) days of the Notice of Award.
2. Bidder shall include the cost of premiums for such Bonds in his Proposal.
3. The Bidder to whom the award is made will be required to furnish the Owner with insurance coverages as set forth in the General Conditions. Bidder shall include the cost of all premiums for insurance in his Proposal.

VII. ACCEPTANCE AND REJECTION OF PROPOSALS

The Owner reserves the right to reject any or all Bids and to waive any informality or technicality in bidding. In addition, the Bidder recognizes the right of the Owner to reject a Bid if the Bidder failed to furnish any required bid security, or to submit the data required by the Bidding Documents, or the Bid is in any way incomplete or irregular. As a condition precedent to contract award, the Bidder's prior experience, financial status and his proposed sub-contractors will be carefully considered. If awarded, the contract will be awarded to the best responsible Bidder complying with the conditions of the Bidding Documents, submitting the lowest acceptable Bid and accepted Alternates, provided the Bid is reasonable and it is in the best interest of the Owner to accept same.

VIII. DRAWINGS AND PROJECT MANUAL

All documents furnished to any person, under any condition, remain property of the Owner, and shall immediately be returned upon request, and in any case not later than fourteen (14) days after opening of bids.

IX. BIDDING DOCUMENTS

1. Each invited General Contractor will be provided with Bid Documents via email in PDF format. Printed Bid Documents will not be provided. General Contractors shall distribute Bid Documents to their sub-bidders.
2. Complete sets of Contract Documents including but not limited to plans, specifications, and project manual shall be used in preparing Proposals; neither the Owner nor Architect assume any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Contract Documents.

X. ALTERNATES

As shown on bid form.

XI. SALES TAX

The Contractor shall include any Kansas or Use Tax, in his Bid Proposal.

XII. SUBSTITUTIONS

All materials shall be as specified with Substitutions as set forth in the General Requirements.

END OF SECTION

Select Bidders List

General Contractors

JE Dunn Construction
1001 Locust Street
Kansas City, MO 64106
Busines: (816) 474-8600
ATTN: Brian Burkett
Brian.Burkett@jedunn.com

Lytle Construction Inc.
1100 SE Hamblen Road
Lee's Summit, Mo 64081
Business: (816) 524-7275
ATTN: Alan Rouse
Alan@lytleconst.com
Cell: (816) 456-3744

StructSure Projects
903 E 104th St. Suite 140
Kansas City, MO 64131
Business (913) 647-9400
ATTN: Michael Worstel
michael.worstel@structsureprojects.com
O 913.647.9455

Sub-Contractors

Mechanical/Plumbing: MMC, P1, US Engineering, Lippert

Electrical: Heartland, Faith, Staco, Shaw

Sprinkler: American, Jayhawk,

Controls (existing system in place): JCI

Nurse Call: Hill Rom

BID FORM

PROPOSAL OF _____
Name of Bidder

To: Keith Crane
kcrane@aciboland.com
ACI/Boland, Inc.
1710 Wyandotte St.
Kansas City, MO 64108

PROPOSAL FOR CONSTRUCTION OF:

HCA Lee's Summit Medical Center – **ICU Expansion**
2100 SE Blue Parkway, Lee's Summit, Missouri 64063

1. Having carefully examined the Invitation to Bid, the Instructions to Bidders, the General Conditions, Special Conditions, the Specifications for the Work and the Drawings similarly entitled and listed in the Project Manual and acknowledged, examining the listed addenda to the drawings and Specifications and having visited the Site, attended the required Pre-Bid Walk-Thru and thereby being thoroughly acquainted with all the conditions affecting the Work including, but not limited to, existing structural, architectural, mechanical, electrical and operational conditions, the undersigned agrees to furnish all labor and materials necessary for the proper completion of the proposed Work shown on the drawings and/or called for in the Specifications relating to the required demolition of existing facilities, protection of all existing facilities during construction operations to insure their continued use throughout the construction period utilizing any manner of specialized construction technique the Owner may deem necessary, to complete the project and all related construction including, but not limited to architectural, mechanical/plumbing and electrical for the lump sum of:

BASE BID

_____. Dollars (\$_____)

ALTERNATES

ALTERNATE BID NO. 1 – No Alternates at this time

(ADD) _____
_____ (\$_____)

THE AMOUNTS OF THE BASE BID, ALTERNATES, MECHANICAL/PLUMBING, FIRE PROTECTION AND ELECTRICAL BIDS SHALL BE SHOWN IN BOTH WRITTEN FORM AND NUMERICAL FORM. IN THE EVENT OF A DISCREPANCY BETWEEN THE TWO, THE WRITTEN AMOUNT WILL GOVERN.

The undersigned agrees to subcontract all aspects of Division 15 Mechanical/Plumbing Construction to:

The cost for the Mechanical/Plumbing contract (Division 15) is:

_____ Dollars (\$_____)

The undersigned agrees to subcontract all aspects of Division 16 Electrical Construction to:

The cost for the Electrical contract (Division 16) is:

_____ Dollars (\$_____)

The cost for the Fire protection contract (Division 21) is:

_____ Dollars (\$_____)

- 2. The undersigned agrees that if awarded the Contract they will complete the Work within _____ consecutive calendar days after receiving the "Notice to Proceed."
- 3. If the undersigned Contractor is notified of the acceptance of this Proposal within thirty (30) calendar days after the time set for receiving proposals, they agree to execute the Agreement in the form set forth in the Contract Documents. Furthermore, the undersigned agrees that they will commence Work within ten (10) calendar days after receiving a written Notice to Proceed and a fully executed Agreement.
- 4. In submitting this Proposal, it is understood all Subcontractors listed will be used without substitution unless authorization is granted by the Owner after the Owner investigates and finds just cause and proper compensation to Owner for such substitution.
- 5. In submitting this Proposal, it is understood the Owner reserves the right to reject any and all Proposals and to enter into further negotiations with any and all Bidders to obtain the Proposal which in Owner's opinion is the best for the Owner.
- 6. The amounts stated above include all taxes, fees, premiums, permits, licenses, etc., applicable to all materials, labor, equipment and all things subject to and upon which such charges are levied or apportioned.
- 7. This Proposal is based upon the use of materials specified by name of manufacturer, brand name, trade name, catalog reference or standard given in the specifications and which will be furnished and installed as part of the Work. Any or all substitutions proposed in lieu of items specified must follow the procedures outlined in General/Special Conditions.
- 8. The following addenda have been received and are considered binding in preparing this Proposal.

<u>Addendum No.</u>	<u>Date</u>	<u>Addendum No.</u>	<u>Date</u>
_____	_____	_____	_____
_____	_____	_____	_____

- 9. The undersigned agrees that their status shall be that of General Contractor and that they will assume all responsibility for the coordination and direction of all Work required by the Contract Documents as directed by the Owner's and Hospital's Representative to be compensated as stipulated above.

10. The undersigned hereby certifies this Proposal is genuine and is not made in the interest of, or in behalf of, any undisclosed person, firm or corporation and is not submitted in accordance with any agreement or rules of any group, association, organization; that he has not directly or indirectly induced or solicited any other bidder to submit a false or sham proposal; that he has not solicited or induced any person or Bidder to refrain from preparing a Proposal, and that he has not sought by collusion or otherwise, to obtain for himself any advantage over any other Bidder or over the Owner.

Signature of Bidder

If a Partnership:

Name of Partnership

by _____ (Signature)

Name of Partner: _____

If a Corporation:

Name of Corporation

by _____ (Signature)

Name of Officer: _____

Title: _____

State of Incorporation:

Street Address

City

Phone Number

Missouri Contractors License Number: _____

Date: _____

(Corporate Seal)
Attest:

Secretary

State of: _____ County of: _____

Subscribed and sworn to before me this _____ day of _____, 2011

Notary Public: _____

My Commission expires: _____

END OF BID FORM

**SECTION 01 10 00
SUMMARY**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Definitions.
- B. Work Covered by Contract Documents.
- C. Work by Owner.
- D. Codes.
- E. Specification and Drawing Conventions.
- F. Intent of the Contract Documents.
- G. Work Sequence.

1.03 DEFINITIONS:

- A. Developer Spec Term: Wherever the term "Developer Spec Term" is used, it shall mean Developer, located at Developer Address. Developer is the owner of the building.
- B. Owner: Wherever the term "Owner" is used, it shall mean HCA Midwest, located Owner Address/City/State/Zip. HCA Midwest shall be the tenant of the interior space being constructed.
- C. Architect: Wherever the term "Architect" is used, it shall mean ACI / Boland Inc., located at Architect Address. ACI / Boland Inc. is the Design Professional of Record for the Project.
- D. CM Spec Term: Wherever the term "CM Spec Term" is used, it shall mean CM Company Name (underlined), located at CM Address/City/State/Zip). The Construction Manager is responsible for overseeing and directing the Work.
- E. Contractor: Wherever the term "Contractor" is used, it shall mean the trade-contractor who holds a prime contract with a portion of the Work.
- F. MEPF Consultant: Wherever the term "MEPF Consultant" is used, it shall mean MEP Company Name (underlined), who have prepared the mechanical, electrical, plumbing, and fire protection design drawings and specifications for the Project.
- G. Civil Engineer: Wherever the term "Civil Engineer" is used, it shall mean Civil Company Name (underlined), who has prepared the civil design drawings and specifications for the Project.

1.04 WORK COVERED BY CONTRACT DOCUMENTS:

- A. The Work is defined by the Contract Documents and consists of the following:
 - 1. Building Addition: 5,945 SF (approx.)
- B. Categories of Work include, but not limited to, the following:
 - 1. General construction.
 - 2. Mechanical, electrical plumbing, and fire protection Work.
- C. Contract Type: Coordinate with Construction Manager.

1.05 DESCRIPTION OF TENANT FINISH WORK

- A. Scope of demolition and removal work is indicated on drawings and specified in Section 02 41 00.
- B. Scope of alterations work is indicated on drawings.
- C. Plumbing: Alter existing system and add new construction, keeping existing in operation.
- D. HVAC: Alter existing system and add new construction, keeping existing in operation.

- E. Electrical Power and Lighting: Alter existing system and add new construction, keeping existing in operation.
- F. Fire Suppression Sprinklers: Alter existing system and add new construction, keeping existing in operation.
- G. Fire Alarm: Alter existing system and add new construction, keeping existing in operation.
- H. Telephone: Alter existing system and add new construction, keeping existing in operation.
- I. Security System: Alter existing system and add new construction, keeping existing in operation.

1.06 PROJECT SCHEDULE

- A. Coordinate project schedule with Construction Manager.

1.07 WORK BY OTHERS

- A. General: Contractor's shall cooperate fully with the Developer and Tenant Owner so work may be carried out smoothly, without interfering with or delaying work under this Contract or work by Owner.
 - 1. Coordinate the Work of this Contract with work performed by the Developer and Tenant Owner.
- B. OWNER FURNISHED / OWNER INSTALLED WORK (OFOI)
 - 1. The Owner will procure separate contracts with vendors to furnish and install furniture, fixtures, and equipment shown on the drawings.
 - 2. Items noted on Drawings as "OF/OI" will be furnished and installed by the Owner.
 - 3. Items noted on Drawings as "NIC" (Not in Contract) will be supplied and installed by Owner.
- C. OWNER FURNISHED / CONTRACTOR INSTALLED WORK (OFCI)
 - 1. General: Products and items indicated in the Contract Documents "OF/CI" will be provided by the Owner under separate contracts for final connection or installation by the Contractor/s.
 - a. Owner's Responsibilities for Owner Furnished / Contractor Installed Work:
 - 1) Arrange for and deliver shop drawings, product data, and samples to the Contractor/s.
 - 2) Arrange and pay for product delivery to site. After delivery, inspect products jointly with Contractor/s.
 - 3) Submit claims for transportation damage and replace damaged, defective, or deficient items.
 - 4) Arrange for manufacturer's warranties, inspections and service.
 - b. Contractor's Responsibilities for Owner Furnished / Contractor Installed Work:
 - 1) The Contractor shall coordinate and schedule with the Owner the requirements and timing required for prompt and proper incorporation into the work.
 - 2) Review Owner furnished shop drawings, product data, and samples to determine if information is adequate as needed for installation.
 - 3) Receive and unload products at site; inspect for completeness or damage, to the extent the Contractor is responsible for installation of Owner provided Work.
 - 4) Handle, store and install Owner furnished Work.
 - 5) Repair or replace items damaged by construction operations.

1.08 BUILDING OCCUPANCY

- A. The Owner intends to occupy the Project upon Substantial Completion.

1.09 CODES

- A. The applicable Codes for this Project include:
 - 1. 2018 International Building Code
 - 2. 2018 International Plumbing Code
 - 3. 2018 International Mechanical Code

4. 2018 International Fire Code
5. 2017 National Electrical Code (NFPA 70)
6. 2012 Life Safety Code (NFPA 101)
7. 2010 ADA Standards for Accessible Design

1.10 USE OF SITE

- A. Coordinate use of project site with the Contractor.

1.11 WORK RESTRICTIONS

- A. Coordinate with Contractor, including:
 1. Work hours;
 2. Utility outages and shutdowns;
 3. Noise, vibration, and odors;
 4. Limitations on use of public streets and with other requirements of authorities having jurisdiction.

1.12 IDENTIFICATION OF ON-SITE PERSONNEL

- A. Coordinate with Contractor.

1.13 SMOKING AND CONTROLLED SUBSTANCES

- A. Coordinate with Contractor.
 1. Smoking is not permitted in the building or on the property.
 2. Use of controlled substances on the property is not permitted.

1.14 FIREARMS

- A. Firearms: Firearms are not permitted on the property.

1.15 BACKGROUND CHECKS

- A. Coordinate with Contractor.

1.16 UNAUTHORIZED ALIEN EMPLOYMENT

- A. Coordinate with Contractor.

1.17 TIME EXTENSIONS FOR UNUSUALLY SEVERE WEATHER

- A. Refer to Section 01 20 00 - Price, Payment, and Contract Modification Procedures

1.18 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. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on 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 published as part of the U.S. National CAD Standard and scheduled on Drawings.

1.19 INTENT OF THE CONTRACT DOCUMENTS

- A. Intent: Drawings and specifications are intended to provide the basis for proper completion of the Work. Anything not expressly set forth but which is reasonable implied or necessary for

proper performance of the project shall be included.

- B. The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all; performance by the Construction Manager shall be required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the indicated results.

1.20 WORK SEQUENCE

- A. Coordinate construction schedule and operations with Contractor.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 10 00

SECTION 01 20 00
PRICE, PAYMENT, AND CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.01 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.

1.02 SECTION INCLUDES

- A. Schedule of Values.
- B. Procedures for preparation and submittal of Applications for Payments.
- C. Contract Modification Procedures.
- D. Time Extensions for Adverse Weather.

1.03 SCHEDULE OF VALUES

- A. Coordinate with Construction Manager.
- B. Schedule of Values Form: AIA G703.
- C. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the specification section. Identify site mobilization.
 - 1. Include in each line item, the amount of Allowances specified in this section. For unit cost Allowances, identify quantities taken from Contract Documents multiplied by the unit cost to achieve the total for the item.
 - 2. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
 - 3. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
- D. Revise Schedule of Values to list approved Change Orders, with each Application for Payment.
- E. Coordination:
 - 1. Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
 - 2. Sub-schedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide sub-schedules showing values coordinated with each phase of payment.

1.04 PROGRESS PAYMENTS

- A. Subject to timely submittal of proper Application for Payment, the Owner agrees to pay an amount to be determined by taking 90-percent (90%) of the value of labor and materials incorporated in the Work, plus material not incorporated in the work but approved by the Architect under the provisions of the Contract Documents, up to the date of application, less the aggregate of all previous payments, the cost of all materials, supplies and equipment paid for by the Owner and deductions provided for in the Contract Documents.
 - 1. 10-percent (10%) shall be held as retainage.
 - a. Reduction in retainage may be considered by the Owner as the Work is completed.
 - 2. The Owner shall endeavor to make payments recommended within ten (10) business days from receipt of the Application for Payment.
 - 3. No interest shall be paid for payments due and unpaid under the Contract Documents.
- B. Time Period: The period of time covered by each Application for Payment is one month, ending on the last day of the month.
- C. Payment Application Form: Submit Form AIA G702 and AIA G703.
 - 1. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored products.

01-17-2022

2. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of work.
3. Forms filled out by hand will not be accepted.
- D. Submission of Application for Payment to Architect:
 1. Submit 'draft' copy of Application for Payment five (5) business days prior to due date for review and comment by the Architect.
 2. When completed, submit one electronic copy of each Application for Payment to Architect. Include the following with each submission:
 - a. Application for Payment, Form AIA G702 and AIA G703.
 - b. Construction progress schedule, revised and current.
 - c. Construction progress photographs specified in Section 01 30 00.
 - d. Partial release of liens from major subcontractors and vendors.
 - e. Affidavits attesting to off-site stored products. Refer to "Stored Materials" Article below.
- 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. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's liens from major subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.
 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 conditional final or full waivers.
 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
 5. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.
- G. When Architect requires substantiating information, submit data justifying dollar amounts in question.

1.05 APPLICATION FOR PAYMENT AT SUBSTANTIAL COMPLETION

- A. Upon the issuance of the Certificate of Substantial Completion, submit an Application for Payment showing 100% completion for portion of the Work claimed as substantially complete.

1.06 APPLICATION FOR FINAL PAYMENT

- A. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Sum, previous payments, and sum remaining due.
- B. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

01-17-2022

1. Consult Owner about the need for additional affidavits and other requirements.
2. Evidence of completion of Project closeout requirements.
3. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid, if appropriate.
4. Updated final statement, accounting for final changes to the Contract Sum.
5. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
6. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
7. AIA Document G707, "Consent of Surety to Final Payment" when applicable.
8. Evidence that all claims have been settled.
9. 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, if required.

1.07 CONTRACT MODIFICATION PROCEDURES

- A. For minor changes not involving an adjustment to the Contract Sum or Contract Time, Architect will issue supplemental instructions directly to the Construction Manager.
- B. Owner-Initiated Changes:
 1. Architect's Supplemental Instructions (ASI): For minor changes not involving an adjustment to the Contract Sum or Contract Time, Architect will issue a document with supplemental instructions, including supplementary or revised drawings, and specifications.
 - a. Construction Manager shall return a signed copy of the ASI to the Architect within five (5) business days.
 2. Request for Proposal (RFP): For changes for which advance pricing is desired, Architect will issue a document that includes a detailed description of proposed changes including supplementary or revised drawings, and specifications.
 - a. Construction Manager shall prepare and submit a fixed price quotation to the Architect within ten (10) business days.
 3. Construction Change Directive (CCD): Architect may issue a Construction Change Directive that instructs the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 - a. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
 - b. Documentation: Contractor shall maintain detailed records on a time and material basis of work required by the CCD.
 - c. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract to the Architect.
- C. Contractor-Initiated Changes:
 1. Construction Manager may propose a change to the Work by submitting a request to the Architect. Submission shall include the following:
 - a. A statement outlining 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 the Contract Time.
 - b. A list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - c. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - d. Costs of labor and supervision directly attributable to the change.
 - e. An updated construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

- f. Comply with requirements in Section 01 25 00 - Substitution Procedures if the proposed change requires substitution of one product or system for product or system specified.
- D. Computation of Change in Contract Amount:
 1. For change requested by Architect for work falling under a fixed price contract, the amount will be based on Contractor's price quotation.
 2. For change requested by Contractor, the amount will be based on the Contractor's request for a change order as approved by Architect.
 3. For pre-determined unit prices and quantities, the amount will be based on the fixed unit prices or allowances.
 4. Changes in the project (additions or credits) where unit prices are not required by the bid documents and value of changes or extra work is determined by an estimate and accepted in a lump sum amount, by cost and percentages, or by cost and a fixed fee, the percentages for overhead and profit, or commission to be allowed for net increases shall in no case exceed the following:

	Overhead & Profit
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- Percentages for overhead and profit will not be allowed on bond premiums.
- E. Substantiation of Costs:
 1. Provide the following data:
 - a. Quantities of products, labor, and equipment.
 - b. Taxes, insurance, and bonds.
 - c. Overhead and profit.
 - d. Justification for any change in Contract Time.
 - e. Credit for deletions from Contract, similarly documented.
 2. Support each claim for additional costs with additional information:
 - a. Origin and date of claim.
 - b. Dates and times work was performed, and by whom.
 - c. Time records and wage rates paid.
 - d. Invoices and receipts for products, equipment, and subcontracts, similarly documented.
- F. Time and Material Work: Submit itemized account and supporting data after completion of change, within time limits indicated in the Conditions of the Contract.
- G. Execution of Change Order/s: Architect will issue Change Order/s for signatures of parties.
- H. Procedures upon final execution of Change Order/s:
 1. Construction Manager shall promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum.
 2. Construction Manager shall promptly revise progress schedules to reflect any change in contract time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.
 3. Construction Manager shall promptly enter changes in Project Record Documents.

1.08 TIME EXTENSIONS FOR ADVERSE WEATHER

- A. The Construction Manager shall comply with all provisions of the General Conditions in submitting any request or claim for extension of Contract Time due to unusually severe weather.
- B. Definitions:

01-17-2022

1. Adverse Weather - atmospheric conditions at a definite time and place which are unfavorable to construction activities.
 2. Unusually Severe Weather: Weather which is more severe than the adverse weather anticipated for the season, location, or activity involved.
- C. Documentation of Adverse Weather:
1. The Construction Manager shall record on their daily construction report the occurrence of adverse weather and the resultant impact to normally scheduled work.
 - a. Actual adverse weather delay days must prevent work on critical activities for 50% or more of contractor's scheduled work day.
 - b. The number of actual adverse weather delay days shall include days impacted by actual adverse weather (even if adverse weather occurred in the previous month), and shall be calculated chronologically from the first to the last day of each month, and be recorded as full work days.
- D. The determination that unusually severe weather occurred does not automatically mean an extension of time will be granted. The Construction Manager must substantiate the unusually severe weather delayed work activities on the critical path of the Progress Schedule for 50-percent or more of the scheduled work day.
- E. The following schedule of monthly anticipated adverse weather delay days will constitute the baseline for monthly weather time evaluations. The construction schedule must include the anticipated adverse weather delays in all weather-affected activities:
- MONTHLY ANTICIPATED ADVERSE WEATHER DELAY **WORK** DAYS BASED ON A FIVE DAY WORK WEEK (Monday - Friday)
- JAN: 10 FEB: 8 MAR: 7 APR: 6 MAY: 7 JUNE: 7 JUL: 5
AUG: 5 SEPT: 5 OCT: 4 NOV: 4 DEC: 9
- F. Calculating Time Extensions for Adverse Weather: If the number of actual adverse weather delay work days in a given month exceeds the number of days anticipated, the difference shall be multiplied by 7/5 to convert any qualifying work day delays to calendar day delays. The resulting number of qualifying lost calendar days shall be added to the Contract Time by change order.
- G. Fair Weather:
1. Full consideration for equivalent fair weather work days shall be given.
 2. If the number of actual adverse weather delays in a given month is less than the number of days anticipated, the difference shall be multiplied by 7/5 to convert any work day increases to calendar days. The resulting number of qualifying extra calendar days will be accumulated and subtracted from any future month's days lost due to unusually severe weather.
 - a. The net cumulative total of extra days and lost days shall not result in a reduction of Contract Time, and the Date of Substantial Completion shall not be changed as a result of unusually favorable weather.
- H. In converting workdays to calendar days, fractions 0.5 and greater shall be rounded up to the next whole number. Fractions less than 0.5 shall be dropped.
- I. The Construction Manager shall summarize and submit a monthly report describing the impact of weather on construction activities.
1. Any request or claim for an extension of time due to unusually severe weather shall be submitted to the Architect within twenty-one (21) days of the last day of the month in which the delay occurred.
 2. Resolution of any weather delay claim shall follow the procedures established by the General Conditions, and as prescribed above.
- J. The Construction Manager shall include the monthly anticipated adverse weather days in their progress schedule.

Lee's Summit Medical Center - ICU Expansion ACIB Project No. 3-21112
01-17-2022

- K. All approved changes in the Contract Time shall be acknowledged and approved by Change Order to the Contract.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 20 00

**SECTION 01 25 00
SUBSTITUTION PROCEDURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Procedural requirements for proposed substitutions

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements

1.03 DEFINITIONS

- A. Substitutions: Changes from Contract Documents requirements proposed by Contractor to materials, products, assemblies, and equipment.
 - 1. Substitutions for Cause: Proposed due to changed Project circumstances beyond Contractor's control, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
 - a. Substitution requests offering advantages solely to the Contractor will not be considered.
- B. CSI/CSC Form 1.5C - Substitution Request (During the Bidding/Negotiating Stage) Current Edition.
- C. CSI/CSC Form 13.1A - Substitution Request (After the Bidding/Negotiating Phase) Current Edition.

1.04 ACTION SUBMITTALS

- A. Substitution Requests: Submit one (1) electronic copy of each request for consideration. 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 in Project Manual at the end of this Section.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
 - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractor's, that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - 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 reports evidencing compliance with building code in effect for Project.
 - j. Detailed comparison of construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If

01-17-2022

- specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, 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 except as indicated in substitution request, is compatible with related materials, 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.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 5 business days of receipt of substitution request, or seven business days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.05 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.06 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.07

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
 - 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
 - 2. Agrees to provide the same warranty for the substitution as for the specified product.
 - 3. Agrees to provide same or equivalent maintenance service and source of replacement parts, as applicable.
 - 4. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
 - 5. Waives claims for additional costs or time extension that may subsequently become apparent.
 - 6. Agrees to reimburse Owner and Architect for review or redesign services associated with re-approval by authorities.
- B. A Substitution Request for specified installer constitutes a representation that the submitter:
 - 1. Has acted in good faith to obtain services of specified installer, but was unable to come to commercial, or other terms.
- C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.
- D. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.
 - 1. Forms indicated in the Project Manual are adequate for this purpose, and must be used.

01-17-2022

- E. Limit each request to a single proposed substitution item.

3.02 SUBSTITUTION PROCEDURES DURING THE BIDDING/NEGOTIATING STAGE

- A. Instructions to Bidders specifies time restrictions for submitting requests for substitutions during the bidding/negotiating period prior to award of contract.
- B. Submittal Form:
 - 1. Submit substitution requests by completing CSI/CSC Form 1.5C - Substitution Request (During the Bidding/Negotiating Stage). Form is attached to the end of this section.
 - a. Use only this form; other forms of submission are unacceptable.

3.03 SUBSTITUTION PROCEDURES DURING CONSTRUCTION

- A. Substitution Types: Changes from Contract Documents requirements proposed by Contractor to materials, products, assemblies, and equipment.
 - 1. Substitutions for Cause: Proposed due to changed Project circumstances beyond Contractor's control, including:
 - a. Unavailability due to a strike, lockout, bankruptcy, discontinuance of the manufacturer of a product, or natural disasters.
 - b. Regulatory changes.
 - c. Submit request for Substitution for Cause within 14 days of discovery of need for substitution, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.
 - 2. Substitutions for Convenience: Proposed due to possibility of offering substantial advantage to the Project.
 - a. Substitution requests offering advantages solely to the Contractor will not be considered.
 - b. Submit request for Substitution for Convenience immediately upon discovery of its potential advantage to the project, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.
 - 1) In addition to meeting general documentation requirements, document how the requested substitution benefits the Owner through cost savings, time savings, greater energy conservation, or in other specific ways.
 - 2) Document means of coordinating of substitution item with other portions of the work, including work by affected subcontractors.
 - 3) Bear the costs engendered by proposed substitution of:
 - (a) Owner's compensation to the Architect for any required redesign, time spent processing and evaluating the request.
- B. Submittal Form:
 - 1. Submit substitution requests by completing CSI/CSC Form 13.1A - Substitution Request for Cause. Form is attached to the end of this section.
 - a. Use only this form; other forms of submission are unacceptable.
- C. Substitutions during construction will not be considered under one or more of the following circumstances:
 - 1. When they are indicated or implied on shop drawing or product data submittals, without having received prior approval.
 - 2. Without a separate written request.
 - 3. When acceptance will require revisions to Contract Documents.

3.04 RESOLUTION

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

3.05 ACCEPTANCE

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

3.06 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. Include completed Substitution Request Forms as part of the Project record. Include both approved and rejected Requests.

3.07 ATTACHMENTS

- A. A facsimile of CSI/CSC Form 1.5C - Substitution Request (During the Bidding/Negotiating Stage) is included after this section.
- B. A facsimile of CSI/CSC Form 13.1A - Substitution Request (During Construction) is included after this section.

END OF SECTION 01 25 00

**SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS**

PART 1 GENERAL

1.01 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.

1.02 SECTION INCLUDES

- A. General Administrative Requirements.
- B. Project Coordination.
- C. Submittal Procedures.
- D. Meetings.
- E. Construction Schedule.
- F. Reports.
- G. Record Documents.
- H. Requests for Interpretation (RFI) procedures.

1.03 RELATED REQUIREMENTS

- Section 01 33 00 - Submittal Procedures
- Section 01 60 00 - Product Requirements
- Section 01 77 00 - Closeout Procedures
- Section 01 78 00 - Closeout Submittals
- Section 01 79 00 - Demonstration and Training

1.04 GENERAL ADMINISTRATIVE REQUIREMENTS

- A. Comply with requirements of Section 01 70 00 - Execution and Closeout Requirements for coordination of execution of administrative tasks with timing of construction activities.
- B. Submittals to Architect include, but not limited to, the following:
 - 1. Requests for Interpretation (RFI).
 - 2. Substitution Requests during Bidding.
 - 3. Shop Drawings, Product Data, and Samples.
 - 4. Test and Inspection Reports.
 - 5. Design data.
 - 6. Manufacturer's Instructions and Field Reports.
 - 7. Applications for Payment.
 - 8. Contract Modification Requests.
 - 9. Progress Schedules.
 - 10. Coordination Drawings.
 - 11. Punch Lists at Substantial Completion.
 - 12. Closeout Submittals.

1.05 PROJECT COORDINATION

- A. Project Coordinator: Shall be the Construction Manager.
- B. Cooperate with the Project Coordinator in allocation of mobilization areas of site; for field offices and sheds, for vehicular access, traffic, and parking facilities.
- C. Administrative Procedures: The Construction Manager shall 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.
 - 1. Such administrative activities include, but are not limited to, the following:
 - a. Preparation of construction schedule.

- b. Preparation of payment applications.
 - c. Installation and removal of temporary facilities and controls.
 - d. Delivery and processing of submittals.
 - e. Progress meetings.
 - f. Pre-installation conferences.
 - g. Project closeout activities.
 - h. Startup and adjustment of systems.
- D. During construction, coordinate use of site and facilities through the Construction Manager.
- E. Comply with Construction Manager's procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.
- F. Comply with instructions of the Construction Manager for use of temporary utilities and construction facilities.
- G. Coordinate field engineering and layout work under instructions of the Construction Manager.
- H. Deliver submittals to Architect through the Construction Manager per the "General Administrative Requirements" Article this Section.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT INFORMATION SUBMITTALS

- A. Project Directory:
- 1. Construction Manager shall 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:
 - a. Name, address, telephone number, and e-mail of each entity working on the Project.
 - b. Number and title of related specification sections for each portion of the Work.
- B. Key Personnel Directory:
- 1. Within ten (10) business 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.
 - a. Post copies of list in project meeting room, in temporary field office and by each construction telephone. Keep list current at all times.

3.02 ELECTRONIC DOCUMENT SUBMITTALS

- A. All documents transmitted for purposes of administration of the contract are to be in electronic (PDF) format and transmitted via an Internet-based Submittal Service, or other electronic means as established for the project.
- 1. Besides submittals for review, information, and closeout, this procedure applies to requests for information (RFIs), progress documentation, contract modification documents (e.g. supplementary instructions, change proposals, change orders), applications for payment, field reports and meeting minutes, punchlists, and any other documents to make part of the project record.
- B. Internet-based Submittal Service:
- 1. The Internet-based Submittal Service shall receive, log and store documents, provide electronic stamping and signatures, and notify addressees via email.
 - 2. The submittal service shall be administered by the Construction Manager.
 - 3. Submit documents in PDF format.
 - 4. The Owner, Contractors, suppliers, Architect and their consultants, will be permitted to use the service at no extra charge.

01-17-2022

- a. Users of the submittal service need an email address, Internet access, and PDF review software that includes ability to mark up and apply electronic stamps (such as Adobe Acrobat, or Bluebeam PDF Revu), unless such software capability is provided by the service provider.
5. Cost: The cost of the service will be paid by the Owner.
6. Training: One (1) web-based training session will be arranged for all participants, with representatives of Architect and Owner participating; further training is the responsibility of the user of the service.
7. Project Closeout: Construction Manager will determine when to terminate the service for the project and is responsible for obtaining archive copies of files for the Owner and Architect.
8. Submittal Service Preference:
 - a. Submittal Exchange (P: 1-800-714-0024)
- C. Paper document submittals will not be reviewed.
- D. All other specified submittal and document transmission procedures apply, except that electronic document requirements do not apply to samples or color selection charts.

3.03 MEETINGS

- A. Coordinate meeting requirements with the Construction Manager.
- B. Meetings include, but not limited to, the following:
 1. Pre-Construction Meeting.
 2. Pre-Installation Conferences.
 3. Construction Progress Meetings.
 4. Coordination Meetings.
 5. Project Closeout Meeting.

3.04 CONSTRUCTION PROGRESS SCHEDULE - SEE SECTION 01 32 16

- A. Refer to Construction Manager for requirements.
- B. Submit updated construction progress schedule with each Application for Payment.

3.05 DAILY CONSTRUCTION REPORTS

- A. Coordinate with Construction Manager.
- B. Daily construction reports shall include only factual information. Do not include personal remarks or opinions regarding operations and/or personnel.
- C. Daily construction reports shall be kept onsite by the Construction Manager. The Construction Manager shall permit access the Owner and Architect

3.06 CONSTRUCTION PROGRESS DOCUMENTATION

- A. Coordinate with Construction Manager.
- B. Provide digital photographs to document the progress of the Work throughout the construction period.
- C. Digital Photographs: 24-bit color, minimum resolution of 1024 by 768, in JPG format; provide files unaltered by photo editing software.
 1. File Naming: Include project identification, date and time of view, and view identification.
 2. Point of View Sketch: Include digital copy of point of view sketch with each electronic submittal; include point of view identification in each photo file name.
 3. Views:
 - a. Interior and/or exterior views as evidence of the progress of the Work during construction
 4. Provide factual presentation.
 5. Provide correct exposure and focus, high resolution and sharpness, maximum depth of field, and minimum distortion.
- D. Submittal Requirements:

01-17-2022

1. Assemble all photos into printable pages (8-1/2" X 11") in PDF format, with 2 to 3 photos per page, each photo labeled with file name. Provide PDF of point of view sketch with photos. Combine into one (1) PDF file per submittal.
2. Assemble all photos, in JPEG format, into one (1) file folder.
3. Delivery Medium: Upload photos and PDF to the designated Internet-Based Document Service.

3.07 COORDINATION DRAWINGS

- A. Provide information required by Construction Manager for preparation of coordination drawings.
- B. Review drawings prior to submission to Architect.
- C. Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make changes as directed and resubmit.

3.08 REQUESTS FOR INTERPRETATION (RFI)

- A. Definition: A request seeking one of the following:
 1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than one place in the Contract Documents.
 2. A resolution to an issue which has arisen due to field conditions and affects design intent.
- B. Whenever possible, request clarifications at the next appropriate project progress meeting, with response entered into meeting minutes, rendering unnecessary the issuance of a formal RFI.
- C. Preparation: Construction Manager shall prepare an RFI immediately upon discovery of a need for interpretation of the Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
 1. Prepare a separate RFI for each specific item.
 - a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
 - b. Do not forward requests which solely require internal coordination between subcontractors.
 2. RFI Format:
 - a. Use AIA G716 - "Request for Information" form.
 3. Combine RFI and its attachments into a single electronic file. PDF format is preferred.
- D. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
 1. Unacceptable Uses for RFIs:
 - a. Approval of submittals.
 - b. Approval of substitutions.
 - c. To request changes that entail change in Contract Time and Contract Sum. Comply with provisions of the Conditions of the Contract.
 - d. Different methods of performing work than those indicated in the Contract Drawings and Specifications. Comply with provisions of the Conditions of the Contract.
 - e. RFI's submitted to request clarification of issues related to means, methods, techniques and sequences of construction or for establishing trade jurisdictions and scopes of subcontracts will be returned without interpretation. Such issues are the Contractor's responsibility.
 2. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.
 3. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, the Contract Documents, with no additional input required to clarify the

01-17-2022

- question. They will be returned without a response, with an explanatory notation.
- a. The Owner reserves the right to assess the Contractor for the costs (on time-and-materials basis) incurred by the Architect, and any of its consultants, due to processing of such RFIs.
- E. RFI Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
1. Official Project name and number, and any additional required identifiers established in Contract Documents.
 2. Discrete and consecutive RFI number, and descriptive subject/title.
 3. Issue date, and requested reply date.
 4. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).
 5. Annotations: Field dimensions and/or description of conditions which have engendered the request.
 6. Contractor's suggested resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.
 7. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.
- F. RFI Log: General Contractor shall administer the RFI Log through the Internet-based Submittal Service.
1. Indicate current status of every RFI. Update log promptly and on a regular basis.
 2. Note dates of when each request is made, and when a response is received.
 3. Highlight items requiring priority or expedited response.
 4. Highlight items for which a timely response has not been received to date.
 5. Identify and include improper or frivolous RFIs.
- G. Review Time:
1. Architect will endeavor to review each RFI, determine action required, and respond no later than ten (10) business days of receipt. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.
 - a. RFIs received after 12:00 noon will be considered as having been received on the next regular business day.
 - b. 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.
 - c. Concurrent Consultant Review: RFI's shall be transmitted simultaneously to the Architect and to Architect's consultants.
 - d. Sequential Review: Where sequential review of RFI's by the Owner, or other parties is required, allow additional time for Architect's response.
 2. The Contractor shall be responsible for delays resulting from the necessity to resubmit and RFI due to insufficient or incorrect information presented in the RFI.
- H. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the project. If in Construction Manager or Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect.
1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended one is to be issued forthwith. Identify the amended RFI with an ' R ' suffix to the original number.
 2. Do not extend applicability of a response to specific item to encompass other similar conditions, unless specifically so noted in the response.

01-17-2022

3. Upon receipt of a response, promptly review and distribute it to all affected parties, and update the RFI Log.
4. Notify Architect within five (5) business days if an additional or corrected response is required by submitting an amended version of the original RFI, identified as specified above.

3.09 SHOP DRAWING SUBMITTALS

- A. Refer to Section 01 33 00 - Submittal Procedures for requirements.

3.10 PROJECT CLOSEOUT SUBMITTALS

- A. Refer to Section 01 78 00 - Closeout Submittals for requirements.

END OF SECTION 01 30 00

**SECTION 01 33 00
SUBMITTAL PROCEDURES**

PART 1 GENERAL

1.01 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.

1.02 SECTION INCLUDES

- A. Requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

1.03 RELATED REQUIREMENTS:

- Section 01 30 00 - Administrative Requirements
- Section 01 40 00 - Quality Requirements
- Section 01 60 00 - Product Requirements
- Section 01 77 00 - Closeout Procedures
- Section 01 78 00 - Closeout Submittals

1.04 DEFINITIONS

- A. Electronic Document Submittal Service: Company regularly providing electronic submittal exchange services for construction projects and is experienced in organizing, handling, storing, logging, and processing electronic information involving shop drawings, RFI's, PR's, CO's and other documents during the construction of the project.
- B. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action.
- C. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements.
- D. 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.

1.05 ELECTRONIC DOCUMENT SUBMITTALS

- A. Electronic Document Submittals: Refer to Article in Section 01 30 00 - Administrative Requirements.

1.06 SHOP DRAWING SUBMITTAL SCHEDULE

- A. Coordinate with Construction Manager.
- B. Submittal Schedule: Construction Manager shall submit a schedule of submittals, arranged in chronological order by dates required by construction schedule.
 - 1. Arrange submittal schedule information to include specification number and title, submittal category (for review or for information), description of item of work covered, and role and name of subcontractor.
 - 2. Account for time required for preparation, review, manufacturing, fabrication and delivery when establishing submittal delivery and review deadline dates.
 - 3. Initial Submittal Schedule:
 - a. Submit concurrently with startup construction schedule.
 - b. Include submittals required during the first 60 calendar days of construction.
 - c. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 - 4. Final Submittal Schedule: Submit concurrently with the first complete submittal of construction schedule.

- a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

1.07 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Architect's Digital Data Files:
 1. One (1) copy of the following digital data files will be provided by the Architect and their Consultant's for the Contractor's use in preparing Shop Drawings:
 - a. Floor plans.
 - b. Reflected ceiling plans.
 2. Formats:
 - a. .RVT files: Revit, operating in Microsoft Windows operating system.
 - b. .PDF files.
 - c. .DWG files: AutoCad.
 3. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 4. Contractor shall execute a electronic release agreement acceptable to Architect and their Consultants.
- B. Coordination:
 1. Construction Manager shall coordinate the preparation, processing, and transmittal of submittals to the Architect with performance of construction activities.
 - a. The Architect shall reserves the right to withhold action on submittals that are received well in advance of the time needed for fabrication and delivery. Priority needing being performed, processing, and those not on the critical path of construction activities at the time they are received.
- C. Processing Time:
 1. Allow 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 transmittals enough in advance of the Work to permit processing.
 - a. Shop drawings received after 12:00 noon will be considered as having been received on the next regular business day.
 - b. Priority will be given to submittals that are on the critical path of construction activities at the time they are received. The Architect reserves the right to withhold action on submittals that are received well in advance of the time required for fabrication and delivery.
 - c. Submittals will be returned to the Construction Manager via the internet-based submittal service.
 2. Initial Review:
 - a. Architectural Submittals: Allow ten (10) business days for the Architect to review each submittal, determine action required, and respond accordingly.
 - 1) Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in progress meeting minutes.
 - 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.
 - (a) Architect will advise Construction Manager when a submittal being processed must be delayed for coordination.
 - b. Concurrent Consultant Review: Shop drawings shall be transmitted simultaneously to the Architect and their consultants for their review. Allow fifteen (15) business days for consultants to review each submittal, determine action required, and respond accordingly.
 - c. Sequential Review: Where sequential review of shop drawings by the Owner, or other party is required, allow fifteen (15) calendar days for Architect's response.
 3. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.

01-17-2022

4. Resubmittal Review: Allow at least five (5) business days for review of each resubmittal.
- D. Deviations and Additional Information: On an attached separate sheet, prepared on letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- E. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.
- F. Construction Manager shall keep one complete set of submittals to be turned over to the Owner at the end of the project. This set of submittals shall be complete, organized by specification section and include all information as submitted and approved for the project.

PART 2 PRODUCTS

2.01 SUBMITTAL PROCEDURES - GENERAL

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 1. Each submittal shall be accompanied with a letter of transmittal. Deliver to Architect through the Electronic Document Submittal Service, or other electronic means, as established for the project.
 2. Submittals shall be provided in "pdf" format electronically.
 3. Identify each submittal by the number of the Specification Section to which it is related.
 4. To the greatest extent possible, submit all product information required as a single submittal for that Specification Section.
 5. Each submittal whether shop drawings or product data shall bear the review stamp of the Contractor, and the Construction Manager, indicating the submittal has been reviewed and is approved.
 - a. Submittals not bearing the Construction Manager or Contractor's stamp will be returned without review.
 6. Architect will return annotated file through the Electronic Document Submittal Service, or other electronic means established for the project.

2.02 SUBMITTAL TYPES

- A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action.
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action.
- C. 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.
 1. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
- D. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 1. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 2. 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.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 - 3. Submit Product Data before or concurrent with Samples.
 - 4. Submit Product Data in the following format:
 - a. PDF electronic file.
- E. Shop Drawings:
 - 1. Prepare Project-specific information, drawn accurately to scale.
 - a. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal based on Architect's or Engineer's digital data drawing files.
 - b. If permitted, the user must obtain and execute a Release and Indemnification Form from the Architect or Engineer responsible for those drawings intended to be used.
 - 2. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 - 3. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
 - 4. Submit Shop Drawings in the following format:
 - a. PDF electronic file.
- F. Samples: Samples shall be for Architect review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
 - 1. Transmit samples directly to the Architect's office.
 - a. Provide corresponding electronic submittal including transmittal form, digital image file illustrating the sample characteristics, and identification information for the record.
 - b. Transmit samples that contain multiple, related components such as accessories together in one submittal package.
 - 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of applicable Specification Section.
 - e. Specification paragraph number and generic name of each item.
 - 3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - 4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit two (2) full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line.
 - b. Architect will return one set with options selected.
 - 5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the

01-17-2022

following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

- a. Number of Samples: Submit two (2) sets of Samples. Architect will retain one Sample set; remainder will be returned.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least two sets of paired units that show approximate limits of variations.
- G. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.
 5. Submit product schedule in the following format:
 - a. PDF electronic file.
- H. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 01 78 00 - Closeout Submittals.
- I. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- J. 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.
- K. 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.
- L. 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.
- M. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- N. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- O. 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.
- P. 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.
- Q. Pre-construction 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.

01-17-2022

- R. 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.
- S. 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.
- T. 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.

2.03 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required 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 of certificate, signed and sealed by the responsible design professional, licensed in the state where the project is constructed, 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

3.01 SHOP DRAWING REVIEW

- A. Contractor's Review:
 - 1. Mark with approval stamp before submitting to Construction Manager.
 - a. Approval stamp shall include project name and location, submittal number, specification section title and number, name of reviewer, date of review, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
- B. Construction Manager's Action: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note all corrections.
 - 1. Mark with action stamp to indicate action to be taken before transmitting to Architect.
 - a. Action stamp shall include submittal number, name of reviewer, and date of review
- C. Architect's Action:
 - 1. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action required.
 - 2. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements.
 - 3. Incomplete submittals will be returned for re-submittal without review.
 - 4. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 01 33 00

**SECTION 01 40 00
QUALITY REQUIREMENTS**

PART 1 GENERAL

1.01 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.

1.02 SECTION INCLUDES

- A. Administrative and procedural requirements quality assurance and quality control.

1.03 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements

1.04 REFERENCES

1.05 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. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- D. Pre-construction Testing: Tests and inspections performed specifically for 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 specified requirements.
- F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- H. 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).

1.06 CONTRACTOR'S PROFESSIONAL DESIGN SERVICES

- A. Coordination: Contractor's professional design services are subject to requirements of project's Conditions for Construction Contract.
- B. Construction-Related Design Services:
 - 1. Provide such engineering design services as may be necessary to plan and safely conduct certain construction operations, pertaining to, but not limited to the following:
 - a. Temporary sheeting, shoring, or supports.
 - b. Temporary scaffolding.
 - c. Temporary bracing.
 - d. Temporary foundation underpinning.
 - e. Temporary hoist(s) and rigging.
 - f. Investigation of soil conditions to support construction equipment.

1.07 CONFLICTING REQUIREMENTS

- A. Referenced Standards: 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 conflicting 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.

1.08 INFORMATIONAL SUBMITTALS

- A. Construction Manager's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.
- C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work.
- D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.

1.09 QUALITY-CONTROL PLAN

- A. Contractor's Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice of Award, and not less than five days prior to pre-construction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out quality-assurance and quality-control responsibilities. Coordinate with construction schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
 - 1. Project quality-control manager may also serve as Project superintendent.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
 - 1. Include required tests and inspections.
 - 2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
 - 3. Owner-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by the Commissioning Authority.

01-17-2022

- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.10 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 reinspectng.
- 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. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
 - 1. Name, address, and telephone number of factory-authorized service representative making report.
 - 2. Statement that equipment complies with requirements.
 - 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 - 4. Statement whether conditions, products, and installation will affect warranty.
 - 5. Other required items indicated in individual Specification Sections.
- D. 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.

01-17-2022

1.11 CERTIFICATES

- A. Certificates: When specified in individual specification sections, submit certification by the manufacturer to Architect, in quantities specified for Product Data.
 - 1. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
 - 2. Certificates may be recent or previous test results on material or product, but must be acceptable to Architect.

1.12 TOLERANCES

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

1.13 TESTING AND INSPECTION

- A. See individual specification sections for testing and inspection required.
- B. Testing Agency Duties:
 - 1. Provide qualified personnel at site. Cooperate with Architect and Construction Manager in performance of services.
 - 2. Perform specified sampling and testing of products in accordance with specified standards.
 - 3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 - 4. Promptly notify Architect and Construction Manager of observed irregularities or non-compliance of Work or products.
 - 5. Perform additional tests and inspections required by Architect.
 - 6. Submit reports of all tests/inspections specified.
- C. Limits on Testing/Inspection Agency Authority:
 - 1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Agency may not approve or accept any portion of the Work.
 - 3. Agency may not assume any duties of Contractor.
 - 4. Agency has no authority to stop the Work.
- D. Contractor Responsibilities:
 - 1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
 - 2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
 - 3. Provide incidental labor and facilities:
 - a. To provide access to Work to be tested/inspected.
 - b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
 - c. To facilitate tests/inspections.
 - d. To provide storage and curing of test samples.
 - 4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
 - 5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
- E. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect.
- F. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.

1.14 MANUFACTURER'S FIELD SERVICES

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

1.15 DEFECT ASSESSMENT

- A. Replace Work or portions of the Work not conforming to specified requirements.
- B. If, in the opinion of Architect, it is not practical to remove and replace the work, Architect will direct an appropriate remedy or adjust payment.

END OF SECTION 01 40 00

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SECTION 01 45 33
CODE-REQUIRED SPECIAL INSPECTIONS

PART 1 GENERAL

1.01 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.

1.02 SECTION INCLUDES

- A. Code-required special inspections.
- B. Testing services incidental to special inspections.
- C. Submittals.

1.03 RELATED REQUIREMENTS

- Section 01 30 00 - Administrative Requirements
- Section 01 40 00 - Quality Requirements
- Section 01 60 00 - Product Requirements

1.04 DEFINITIONS

- A. Code or Building Code: ICC (IBC)-2012 Edition of the International Building Code and specifically, Chapter 17 - Special Inspections and Tests.
- B. Authority Having Jurisdiction (AHJ): Agency or individual officially empowered to enforce the building, fire and life safety code requirements of the permitting jurisdiction in which the Project is located.
- C. International Accreditation Service, Inc. (IAS).
- D. National Institute of Standards and Technology (NIST).
- E. Special Inspection:
 - 1. Special inspections are inspections and testing of materials, installation, fabrication, erection or placement of components and connections mandated by the AHJ that also require special expertise to ensure compliance with the approved contract documents and the referenced standards.
 - 2. Special inspections are separate from and independent of tests and inspections conducted by the Owner or Contractor for the purposes of quality assurance and contract administration.

1.05 REFERENCES

- A. ACI 318 - Building Code Requirements for Structural Concrete 2019, with Errata (2021).
- B. ICC (IBC)-2015 - International Building Code 2015.
- C. AISC 341 - Seismic Provisions for Structural Steel Buildings 2016 (Revised 2020).
- D. AISC 360 - Specification for Structural Steel Buildings 2016 (Revised 2021).
- E. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- F. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field 2021a.
- G. ASTM C172/C172M - Standard Practice for Sampling Freshly Mixed Concrete 2017.
- H. ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction 2019.
- I. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection 2021.
- J. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing 2021.

- K. ASTM E2570/E2570M - Standard Test Methods for Evaluating Water-Resistive Barrier (WRB) Coatings Used under Exterior Insulation and Finish Systems (EIFS) or EIFS with Drainage 2007, with Editorial Revision (2014).
- L. AWC 117 - Technical Manual 12-B; Standard Practice for the Testing and Inspection of Field Applied Thin Film Intumescent Fire-Resistive Materials; an Annotated Guide 2014.
- M. AWS D1.4/D1.4M - Structural Welding Code - Steel Reinforcing Bars 2018.
- N. IAS AC89 - Accreditation Criteria for Testing Laboratories 2020.
- O. IAS AC291 - Accreditation Criteria for Special Inspection Agencies 2017.
- P. ICC (IBC)-2012 - International Building Code 2012.

1.06 SUBMITTALS

- A. Special Inspection Agency Qualifications: Prior to the start of work, the Special Inspection Agency shall:
 - 1. Submit agency name, address, and telephone number, names of full time registered Engineer and responsible officer.
 - 2. Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.
 - 3. Submit certification that Special Inspection Agency is acceptable to AHJ.
 - 4. Submit documentation that Special Inspection Agency is accredited by IAS according to IAS AC291.
- B. Testing Agency Qualifications: Prior to the start of work, the Testing Agency shall:
 - 1. Submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.
 - 2. Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.
 - 3. Submit certification that Testing Agency is acceptable to AHJ.
 - 4. Submit documentation that Testing Agency is accredited by IAS according to IAS AC89.
- C. Smoke Control Testing Agency Qualifications: Prior to the start of work, the Testing Agency shall:
 - 1. Submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.
 - 2. Submit documentary evidence that agency has appropriate credentials and documented experience in fire protection engineering, mechanical engineering and HVAC air balancing.
 - 3. Submit certification that Testing Agency is acceptable to AHJ.
 - 4. Submit documentation that Testing Agency is accredited by IAS according to IAS AC89.
- D. Manufacturer's Qualification Statement: Manufacturer shall submit documentation of manufacturing capability and quality control procedures. Include documentation of AHJ approval.
- E. Fabricator's Qualification Statement: Fabricator shall submit documentation of fabrication facilities and methods as well as quality control procedures. Include documentation of AHJ approval.
- F. Special Inspection Reports: After each special inspection, Special Inspector shall promptly submit two copies of report; one to Architect and one to the AHJ.
 - 1. Include:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of Special Inspector.
 - d. Date and time of special inspection.
 - e. Identification of product and specifications section.

01-17-2022

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

1.07 SPECIAL INSPECTION AGENCY

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

1.08 TESTING AND INSPECTION AGENCIES

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

1.09 QUALITY ASSURANCE

- A. Special Inspection Agency Qualifications:
 - 1. Independent firm specializing in performing testing and inspections of the type specified in this section.
 - 2. Accredited by IAS according to IAS AC291.
- B. Testing Agency Qualifications:

01-17-2022

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

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SPECIAL INSPECTIONS - GENERAL

- A. The Owner will employ the services of a Special Inspection Agency to perform inspections during construction on the types of work listed in Section 1705 of the 2012 International Building Code (IBC), including:
1. Steel construction (Section 1705.2)
 2. Concrete construction (Section 1705.3)
 3. Masonry construction (Section 1705.4)
 4. Soils (Section 1705.6)
 5. Cast-in-place deep foundations (Section 1705.8)
 6. Helical pile foundations (Section 1705.9)
 7. Wind resistance (Section 1705.10)
 8. Seismic resistance (Section 1705.11)
 9. Seismic resistance (Section 1705.12)
 10. Sprayed fire-resistant materials (Section 1705.13)
 11. Mastics and Intumescent fire-resistant materials (Section 1705.14)
 12. Exterior insulation and finish systems (EIFS) (Section 1705.15)
 13. Fire-resistant penetrations and joints (Section 1705.16)
 14. Smoke control (Section 1705.17)
- B. SPECIAL INSPECTIONS - FREQUENCY
- C. Frequency of Special Inspections: Special Inspections are indicated as continuous or periodic.
1. Continuous Special Inspection: Special Inspection Agency shall be present in the area where the work is being performed and observe the work at all times the work is in progress.
 2. Periodic Special Inspection: Special Inspection Agency shall be present in the area where work is being performed and observe the work part-time or intermittently and at the completion of the work.

3.02 SPECIAL INSPECTIONS - STEEL CONSTRUCTION

- A. Perform inspections of steel construction in accordance with the requirements of Section 1705.2 of the 2015
- B. Structural Steel: Special inspections for structural steel shall be in accordance with the requirements of AISC 360
- C. Steel Construction (Other than structural steel): Required verification and inspection of steel construction per Table 1705.2.2 of the 2012 International Building Code (ICC (IBC)-2012), including:
1. Material verification of cold-formed steel deck:
 2. Inspection of welding:
 - a. Floor and/or roof deck welds per AWS D1.3; periodic.
 - b. Reinforcing Steel: Comply with AWS D1.4/D1.4M and ACI 318, Section 3.5.2.

3.03 SPECIAL INSPECTIONS - CONCRETE CONSTRUCTION

- A. Inspections by Owner: Perform required verification and inspection of concrete construction, per Table 1705.3 of the 2010 International Building Code (IBC).
1. Exception: Concrete testing and sampling performed by Concrete Contractor.

01-17-2022

- B. The Concrete Contractor shall employ the services of a Special Inspection Agency to perform sampling and testing of concrete specimens in accordance with the requirements of Table 1705.3, Item No. 6, of the 2012 International Building Code, including:
 - 1. Fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete. Verify compliance with ASTM C172/C172M, ASTM C31/C31M and ACI 318; continuous.

3.04 SPECIAL INSPECTIONS - MASONRY CONSTRUCTION

- A. Masonry construction shall be inspected and verified in accordance with the quality assurance requirements of TMS 402 / ACI 530 / ASCE 5 and TMS 602 / ACI 530.1 / ASCE 6.
 - 1. Exceptions:
 - a. Empirically designed masonry and masonry veneer in structures classified as Risk Category I, II, or III.
- B. Occupancy (Risk) Category: II, per 2012 IBC, Section 1604.5

3.05 SPECIAL INSPECTIONS - SOILS

- A. Perform required verification and inspection of soils, per Table 1705.6 of the 2012 International Building Code (IBC).
- B. Materials and Placement: Verify each item below complies with approved construction documents and approved geotechnical report:
 - 1. Design bearing capacity of material below shallow foundations; periodic.
 - 2. Design depth of excavations and suitability of material at bottom of excavations; periodic.
 - 3. Materials, densities, lift thicknesses; placement and compaction of backfill: continuous.
 - 4. Subgrade, prior to placement of compacted fill; periodic.
- C. Testing: Classify and test excavated material; periodic.

3.06 SPECIAL INSPECTIONS FOR SPRAYED FIRE-RESISTANT MATERIALS

- A. When applicable, special inspections for sprayed fire-resistive materials applied to floor, roof, and wall assemblies and structural members shall be in accordance with Sections 1705.13 of the 2018 IBC.
- B. Sprayed Fire Resistant Materials, General:
 - 1. Verify compliance of sprayed-fire resistant materials with specific fire-rated assemblies indicated in approved contract documents, and with applicable requirements of the building code.
 - 2. Perform special inspections after rough installation of electrical, mechanical, plumbing, automatic fire sprinkler and suspension systems for ceilings.
- C. Physical and visual tests: Verify compliance with fire resistance rating.
 - 1. Condition of substrates; periodic.
 - 2. Thickness of sprayed fire resistant material; periodic.
 - 3. Density of sprayed fire resistant material in pounds per cubic foot (kg per sq m); periodic.
 - 4. Bond strength (adhesion and cohesion); periodic.
 - 5. Condition of finished application; periodic.
- D. Structural member surface conditions:
 - 1. Inspect structural member surfaces before application of sprayed fire resistant materials; periodic.
 - 2. Verify preparation of structural member surfaces complies with approved contract documents and manufacturer's written instructions; periodic.

3.07 SPECIAL INSPECTIONS - MASTIC AND INTUMESCENT FIRE-RESISTANT COATINGS

- A. When applicable, perform inspections and associated testing and sampling of mastic and intumescent fire-resistive coatings, in accordance with the requirements of Section 1705.15 of the 2012 International Building Code.
 - 1. Verify mastic and intumescent fire resistant coatings comply with AWCI 12-B and the fire resistance rating indicated on approved contract documents.

01-17-2022

3.08 SPECIAL INSPECTIONS - EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS)

- A. Special Inspections: Not required per Section 1705.15 of the 2012 IBC.
- B. Verify water resistive barrier coating applied over sheathing complies with ASTM E2570/E2570M.

3.09 SPECIAL INSPECTIONS FOR FIRE RESISTANT PENETRATIONS AND JOINTS

- A. Occupancy (Risk) Category: II, per 2012 IBC, Section 1604.5
 - 1. Special Inspections not required per Section 1705.16 of the 2012 IBC.

3.10 SPECIAL INSPECTIONS - SMOKE CONTROL

- A. When applicable, perform inspections and associated sampling and testing of smoke control in accordance with IBC 2012, Section 1705.17. Test smoke control systems as follows:
 - 1. During erection of ductwork and prior to concealment for the purpose of leakage testing and recording of device location.
 - 2. Prior to occupancy and after sufficient completion for the purposes of pressure difference testing, flow measurements and detection and control verification.

3.11 SPECIAL INSPECTIONS - SEISMIC RESISTANCE

- A. Design Requirements:
 - 1. Building Code: 2012 IBC
 - 2. Occupancy (Risk) Category (Section 1604.5): II
 - 3. Site Classification (Section 1613.3.2): C
 - 4. Seismic Design Category (Section 1613.3.5): B
- B. Special Inspections: Seismic Design Category A and B only: Special inspections not required.
- C. Special Inspections:
 - 1. Seismic Force-Resisting Systems (Seismic Design Category C, D, E, or F only):
 - a. Structural Steel: Comply with the quality assurance requirements of AISC 341.
 - b. Structural Wood
 - c. Cold-Formed Steel Light Frame Construction
 - 2. Architectural Components: Erection and fastening of exterior cladding, interior and exterior non-bearing walls, interior and exterior veneer (Seismic Design Category D, E or F only); periodic.
 - 3. Mechanical and Electrical Components:
 - a. Anchorage of electric equipment required for emergency or standby power systems (Seismic Design Category C, D, E or F only); periodic.
 - b. Installation and anchorage of other electrical equipment (Seismic Design Category E or F only); periodic.
 - c. Installation of piping systems for flammable, combustible or highly-toxic contents and associated mechanical units (Seismic Design Category C, D, E or F only); periodic.
 - d. Installation of HVAC ductwork that will contain hazardous materials (Seismic Design Category C, D, E or F only); periodic.
 - e. Vibration isolation systems where the approved contract documents require a nominal clearance of 1/4 inch (6.35 mm) or less between support frame and seismic restraint (Seismic Design Category C, D, E or F only); periodic.
 - 4. Storage Racks (Seismic Design Category D, E or F only): Anchorage; periodic.
- D. Testing and Qualification for Seismic Resistance:
 - 1. Seismic Force-Resisting Systems (Seismic Design Category C, D, E, or F only): Comply with Sections 1705.12.1 and 1705.12.2, as applicable.
 - 2. Designated Seismic System (Seismic Design Category C, D, E or F only): Comply with Section 1705.12.3 and ASCE 7 Section 13.2.2
 - 3. Architectural, Mechanical, and Electrical Components (Seismic Design Category C, D, E, or F only): Comply with Section 1705.12.3 and ASCE 7 Section 13.2.1

01-17-2022

3.12 OTHER SPECIAL INSPECTIONS

- A. Provide for special inspection of work that, in the opinion of the AHJ, is unusual in nature.
- B. For the purposes of this section, work unusual in nature includes, but is not limited to:
 - 1. Construction materials and systems that are alternatives to materials and systems prescribed by the building code.
 - 2. Unusual design applications of materials described in the building code.
 - 3. Materials and systems required to be installed in accordance with the manufacturer's instructions when said instructions prescribe requirements not included in the building code or in standards referenced by the building code.
- C. Alternative Test Procedures: Where approved rules and standards do not exist, test materials and assemblies as required by AHJ, or provide AHJ with documentation of quality and manner in which those materials and assemblies are used.

3.13 SPECIAL INSPECTION AGENCY DUTIES AND RESPONSIBILITIES

- A. Special Inspection Agency shall:
 - 1. Verify samples submitted by Contractor or Owner comply with the referenced standards and the approved contract documents.
 - 2. Perform specified sampling and testing of products in accordance with specified REFERENCES.
 - 3. Ascertain compliance of materials and products with requirements of Contract Documents.
 - 4. Promptly notify Construction Manager or Architect of observed irregularities or non-conformance of work or products.
 - 5. Submit reports of all tests or inspections specified.
- B. Limits on Special Inspection Agency Authority:
 - 1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Agency may not approve or accept any portion of the work.
 - 3. Agency may not assume any duties of Contractor.
 - 4. Agency has no authority to stop the work.
- C. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect.
- D. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.

3.14 TESTING AGENCY DUTIES AND RESPONSIBILITIES

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

- D. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.

3.15 CONTRACTOR DUTIES AND RESPONSIBILITIES

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

END OF SECTION 01 45 33

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

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Temporary Services: Provide temporary services and utilities, including payment of utility costs including the following:
 - 1. Water (potable and non-potable).
 - 2. Lighting and power.
 - 3. Metering.
 - 4. Telephone.
 - 5. Toilet facilities.
 - 6. Materials storage.
- B. Construction Facilities: Provide construction facilities, including payment of utility costs including the following.
 - 1. Construction equipment.
 - 2. Dewatering and pumping.
 - 3. Enclosures.
 - 4. Heating.
 - 5. Lighting.
 - 6. Access.
 - 7. Roads.
- C. Security and Protection: Provide security and protection requirements including the following.
 - 1. Fire extinguishers.
 - 2. Site enclosure fence, barricades, warning signs, and lights.
 - 3. Building enclosure and lock-up.
 - 4. Environmental protection.
- D. Personnel Support: Provide personnel support facilities including the following.
 - 1. General Contractor's field office with telephone, fax and data connection.
 - 2. Sanitary facilities.
 - 3. Drinking water.
 - 4. Project identification sign.
 - 5. Cleaning.

1.03 DEWATERING

- A. Provide temporary means and methods for dewatering all temporary facilities and controls.
- B. Maintain temporary facilities in operable condition.

1.04 TEMPORARY UTILITIES

- A. General Contractor shall provide and pay for all electrical power, lighting, water, heating and cooling, and ventilation required in areas of new construction. As work progresses new permanent facilities may be used.

1.05 TELECOMMUNICATIONS SERVICES

- A. Provide, maintain, and pay for telecommunications services to field office.
- B. Telecommunications services shall include:
 - 1. Windows-based personal computer dedicated to project telecommunications, with necessary software and laser printer.
 - 2. Telephone Land Lines: One line, minimum; one handset per line.
 - 3. Internet Connections: Minimum of one; DSL modem or faster.

4. Email: Account/address reserved for project use.
5. Facsimile Service: Fax-to-email software on personal computer.

1.06 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.
- B. New permanent facilities may be used during construction operations.
- C. Maintain daily in clean and sanitary condition.
- D. At end of construction, return facilities to same or better condition as originally found.

1.07 BARRIERS

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

1.08 TEMPORARY CONSTRUCTION FENCING

- A. Construction: Commercial grade chain link fence.
- B. Provide 6 foot (1.8 m) high temporary fencing around construction site; equip with vehicular and pedestrian gates with locks.

1.09 EXTERIOR ENCLOSURES

- A. Provide temporary insulated weather tight closure of exterior openings to accommodate acceptable working conditions and protection for Products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

1.10 INTERIOR ENCLOSURES

- A. Coordinate with General Contractor.

1.11 VEHICULAR ACCESS AND PARKING

- A. Comply with regulations relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles.
- B. Coordinate access and haul routes with governing authorities and General Contractor.
- C. Provide and maintain access to fire hydrants, free of obstructions.
- D. Provide means of removing mud from vehicle wheels before entering streets.
- E. Designated existing on-site roads may be used for construction traffic.
- F. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking.

1.12 WASTE REMOVAL

- A. Coordinate with General Contractor.

1.13 FIELD OFFICES

- A. Field Office: Weathertight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture, drawing rack, and drawing display table.
- B. Provide space for Project meetings, with table and chairs to accommodate at least 6 persons.

1.14 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.
- B. Clean and repair damage caused by installation or use of temporary work.

Lee's Summit Medical Center - ICU Expansion ACIB Project No. 3-21112
01-17-2022

C. Restore new permanent facilities used during construction to specified condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 50 00

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**SECTION 01 60 00
PRODUCT REQUIREMENTS**

PART 1 GENERAL

1.01 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.

1.02 SECTION INCLUDES

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

1.03 RELATED REQUIREMENTS

- A. Section 01 25 00 - Substitution Procedures
- B. Section 01 30 00 - Administrative Requirements
- C. Section 01 40 00 - Quality Requirements
- D. Section 01 70 00 - Execution and Closeout Requirements
- E. Section 01 78 00 - Closeout Submittals

1.04 DEFINITIONS

- A. Products: Items obtained 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. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process 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.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," 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 additional manufacturers named in the specification.

1.05 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
 - 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Construction Manager of approval or rejection of proposed

01-17-2022

comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 "Submittal Procedures." Show compliance with requirements.

1.06 REFERENCES

- A. 16 CFR 260.13 - Guides for the Use of Environmental Marketing Claims; Federal Trade Commission; Recycled Content Current Edition.
- B. C2C (DIR) - C2C Certified Products Registry; Cradle to Cradle Products Innovation Institute Current Edition.
- C. EN 15804 - Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products 2014.
- D. ISO 14025 - Environmental Labels and Declarations - Type III Environmental Declarations - Principles and Procedures 2006.
- E. ISO 14040 - Environmental management - Life cycle assessment - Principles and framework 2006 (Amended 2020).
- F. ISO 14044 - Environmental management - Life cycle assessment - Requirements and guidelines 2006 (Amended 2020).
- G. ISO 21930 - Sustainability in buildings and civil engineering works -- Core rules for environmental product declarations of construction products and services 2017.

1.07 SUBMITTALS

- A. Product Data Submittals:
 - 1. Refer to Section 01 33 00 for submittal procedures.
- B. Shop Drawing Submittals:
 - 1. Refer to Section 01 33 00 for submittal procedures.
- C. Sample Submittals:
 - 1. Refer to Section 01 33 00 for submittal procedures.

1.08 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product 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.
- B. Chain-of-Custody (COC): A procedure that tracks a product from the point of harvest or extraction to its end use, including successive stages of processing, transformation, manufacturing, and distribution.
- C. Chain-of-Custody Certificates: Certificates signed by manufacturers and fabricators certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001.
- D. Composite Wood and Agrifiber: Products made of wood particles and/or plant material pressed and bonded with adhesive or resin such as particleboard, medium density fiberboard (MDF), plywood, wheatboard, strawboard, panel substrates, and door cores.
- E. Corporate Sustainability Report: A third-party verified report that outlines the environmental impacts of extraction operations and activities associated with the manufacturer's product and the product's supply chain.
- F. Cradle-to-Cradle Certified: End use product certified Cradle-to-Cradle v2 Basic or Cradle-to-Cradle v3 Bronze, minimum, as evidenced by C2C (DIR).

- G. Environmental Product Declaration (EPD): Publicly available, critically reviewed life cycle analysis having at least a cradle-to-gate scope.
 - 1. Good: Product-specific; compliant with ISO 14044.
 - 2. Better: Industry-wide, generic; compliant with ISO 21930, or with ISO 14044, ISO 14040, ISO 14025, and EN 15804; Type III third-party certification with external verification, in which the manufacturer is recognized as the program operator.
 - 3. Best: Commercial-product-specific; compliant with ISO 21930, or with ISO 14044, ISO 14040, ISO 14025, and EN 15804; Type III third-party certification with external verification, in which the manufacturer is recognized as the program operator.
 - 4. Where demonstration of impact reduction below industry average is required, submit both industry-wide and commercial-product-specific declarations; or submit at least 5 declarations for products of the same type by other manufacturers in the same industry.
- H. Health Product Declarations (HPD): Complete, published declaration with full disclosure of known hazards, prepared using one of the HPDC (HPD-OLT) online tools.
- I. Recycled Content: Determine percentage of post-consumer and pre-consumer (post-industrial) content separately, using the guidelines contained in 16 CFR 260.13.
 - 1. Previously used, reused, refurbished, and salvaged products are not considered recycled.
 - 2. Wood fabricated from timber abandoned in transit to original mill is considered reused, not recycled.
 - 3. Determine percentage of recycled content of any item by dividing the weight of recycled content in the item by the total weight of materials in the item.
 - 4. Determine value of recycled content of each item separately, by multiplying the content percentage by the value of the item.
 - 5. Acceptable Evidence:
 - a. For percentage of recycled content, information from manufacturer.
- J. Regional Materials: Materials that are extracted, harvested, recovered, and manufactured within a radius of 100 miles (160.9 Km) from the Project site.
- K. Reused Products: Materials and equipment previously used in this or other construction, salvaged and refurbished as specified.
 - 1. Wood fabricated from timber abandoned in transit after harvesting is considered reused, not recycled.
 - 2. Acceptable Evidence: Information about the origin or source, from Contractor or supplier.
- L. Source Location: Location of harvest, extraction, recovery, or manufacture; where information about source location is required to be submitted, give the postal address:
 - 1. In every case, indicate the location of final assembly.
 - 2. For harvested products, indicate location of harvest.
 - 3. For extracted (i.e. mined) products, indicate location of extraction.
 - 4. For recovered products, indicate location of recovery.
 - 5. For products involving multiple manufacturing steps, provide a description of the process at each step, with location.
 - 6. Acceptable Evidence:
 - a. Manufacturer's certification.
 - b. Life cycle analysis (LCA) performed by third-party.
- M. Sustainably Harvested Wood: Solid wood, wood chips, and wood fiber certified or labeled by an organization accredited by one of the following:
 - 1. The Forest Stewardship Council, The Principles for Natural Forest Management; for Canada visit <http://www.fsccanada.org>, for the USA visit <http://www.fscus.org>.
 - 2. Acceptable Evidence: Copies of invoices bearing the certifying organization's certification numbers.

1.09 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written

01-17-2022

instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine 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. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.
7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.10 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:** Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 2. **Special Warranty:** Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. **Special Warranties:** Prepare a written document that contains appropriate terms and identification, ready for 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.

PART 2 PRODUCTS

2.01 PRODUCT SELECTION PROCEDURES

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

01-17-2022

5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. Product Selection Procedures:
 1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 3. Products:
 - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
 4. Manufacturers:
 - a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
 5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated 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 requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
- C. Visual Matching Specification: Where Specifications require "match Architect's sample", provide 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 requirements in Section 01 25 00 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.02 NEW PRODUCTS

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

2.03 PRODUCT OPTIONS

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

2.04 MAINTENANCE MATERIALS

- A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.
- B. Deliver to Project site; obtain receipt prior to final payment.
- C. Store maintenance materials in a location approved by the Owner.

PART 3 EXECUTION

3.01 SUBSTITUTION PROCEDURES

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

3.02 OWNER-SUPPLIED PRODUCTS

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

3.03 TRANSPORTATION AND HANDLING

- A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.
- B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.
- C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- D. Transport and handle products in accordance with manufacturer's instructions.
- E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
- F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.
- H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.04 STORAGE AND PROTECTION

- A. Provide protection of stored materials and products against theft, casualty, or deterioration.
- B. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.
 - 1. Structural Loading Limitations: Handle and store products and materials so as not to exceed static and dynamic load-bearing capacities of project floor and roof areas.
- C. Store and protect products in accordance with manufacturers' instructions.
- D. Store with seals and labels intact and legible.
- E. Arrange storage of materials and products to allow for visual inspection for the purpose of determination of quantities, amounts, and unit counts.
- F. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- G. For exterior storage of fabricated products, place on sloped supports above ground.
- H. Provide off-site storage and protection when site does not permit on-site storage or protection.
 - 1. Execute a formal supplemental agreement with Owner allowing off-site storage, for each occurrence.

- I. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.
- J. Comply with manufacturer's warranty conditions, if any.
- K. Do not store products directly on the ground.
- L. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- M. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- N. Prevent contact with material that may cause corrosion, discoloration, or staining.
- O. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- P. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION 01 60 00

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**SECTION 01 78 00
CLOSEOUT SUBMITTALS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Project Record Documents.
- B. Operation and Maintenance Data.
- C. Warranties.

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements
- B. Section 01 73 00 - Execution
- C. Section 01 78 00 - Closeout Submittals
- D. Individual Product Sections: Specific requirements for operation and maintenance data.
- E. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

- A. Project Record Documents.
 - 1. Transmit one (1) set of electronic drawings to the Architect for review.
 - 2. Transmit Record Documents prior to the Substantial Completion Inspection.
 - 3. The record drawings will be reviewed and returned, with Architect comments. Revise record drawings as required.
 - 4. Submit one (1) electronic copy and two (2) sets of paper copies of the final record documents in final form prior to final inspection.
- B. Operation and Maintenance (O&M) Data.
 - 1. Submit one electronic of preliminary draft or proposed formats and outlines of contents before start of Work. Architect will review draft and return one copy with comments.
 - 2. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
 - 3. Submit one (1) electronic copy of completed O&M documents prior to the Substantial Completion Inspection. This copy will be reviewed and returned, with Architect comments. Revise content of O&M documents as required.
 - 4. Final Submission: Submit One (1) electronic copy and Two (2) sets of paper copies of the final record documents in final form prior to final inspection.
- C. Warranties.
 - 1. For equipment or component parts of equipment put into service, submit one (1) electronic copy of warranty and bond documents prior to the Substantial Completion Inspection. This copy will be reviewed and returned, with Architect comments. Revise content of documents as required.
 - 2. Submit one electronic file, and one paper copy of the final warranty and bond documents in final form prior to final inspection.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the Contract.
 - 5. Reviewed shop drawings, product data, and samples.
 - 6. Manufacturer's instruction for assembly, installation, and adjusting.

01-17-2022

- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress.
- E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 - 1. Changes made by Addenda and modifications.
- F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured depths of foundations in relation to finish first floor datum.
 - 2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - 3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 - 4. Field changes of dimension and detail.
 - 5. Details not on original Contract drawings.
- G. Distribution:
 - 1. Provide one (1) paper copy of the Record Drawings for use by the Owner.
 - 2. Electronic File: Scan all Record Drawings and Shop Drawings and assemble into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

3.02 OPERATION AND MAINTENANCE (O&M) DATA

- A. General:
 - 1. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
 - 2. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
 - 3. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
 - 4. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.
- B. For Each Product, Applied Material, and Finish:
 - 1. Product data, with catalog number, size, composition, and color and texture designations.
 - 2. Information for re-ordering custom manufactured products.
 - 3. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.
 - 4. Moisture protection and weather-exposed products: Include product data listing applicable REFERENCES, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.
 - 5. Additional information as specified in individual product specification sections.
 - 6. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.
- C. For Each Item of Equipment and Each System:
 - 1. Description of unit or system, and component parts.
 - 2. Identify function, normal operating characteristics, and limiting conditions.
 - 3. Include performance curves, with engineering data and tests.
 - 4. Complete nomenclature and model number of replaceable parts.
 - 5. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

01-17-2022

6. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.
7. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
8. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
 - a. Include HVAC outdoor and exhaust air damper calibration strategy.
 - 1) Include provisions which ensure that full closure of dampers can be achieved.
9. Provide servicing and lubrication schedule, and list of lubricants required.
10. Include manufacturer's printed operation and maintenance instructions.
11. Include sequence of operation by controls manufacturer.
12. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
13. Provide control diagrams by controls manufacturer as installed.
14. Provide coordination drawings, with color coded piping diagrams as installed.
15. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
16. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
17. Include test and balancing reports.
18. Additional Requirements: As specified in individual product specification sections.

3.03 ASSEMBLY OF OPERATION AND MAINTENANCE (O&M) MANUALS

- A. Assemble operation and maintenance (O&M) data into durable manuals for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.
- B. Where systems involve more than one specification section, provide separate tabbed divider for each system.
- C. Binders: Commercial quality, 8-1/2 by 11 inch (216 by 280 mm) three D side ring binders with durable plastic covers; 2 inch (50 mm) maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
 1. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.
 2. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Architect, Consultants, Contractor and subcontractors, with names of responsible parties.
 3. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.
 4. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.
 5. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.
 6. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- D. Arrangement of Contents: Organize each volume in parts as follows:
 1. Project Directory.
 2. Table of Contents, of all volumes, and of this volume.
 3. Operation and Maintenance Data: Arranged by system, then by product category.
 - a. Source data.
 - b. Product data, shop drawings, and other submittals.
 - c. Operation and maintenance data.
 - d. Field quality control data.

- e. Photocopies of warranties and bonds.
- E. Distribution:
 - 1. Paper Copies: Provide one (1) copy of O&M Manuals for use by the Owner.
 - 2. Electronic File: Scan all O&M data and assemble complete O&M 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.

3.04 ASSEMBLY OF WARRANTY MANUALS

- A. Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.
 - 1. Warranties shall commence on the Date of Substantial Completion, no exceptions.
 - 2. Verify that documents are in proper form, contain full information, and are notarized.
 - 3. Co-execute submittals when required.
 - 4. Retain warranties and bonds until time specified for submittal.
- B. Warranty Manual: Bind in commercial quality 8-1/2 by 11 inch (216 by 279 mm) three D side ring binder/s with durable plastic cover/s.
 - 1. Cover: Identify each binder with typed or printed title WARRANTIES, with title of Project; name, address and telephone number of General Contractor and equipment supplier; and name of responsible company principal.
 - 2. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.
 - 3. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
- C. Distribution:
 - 1. Paper copies: Provide one (1) copy of Warranty Manual for use by the Owner.
 - 2. Warranty Electronic File: Scan warranties and assemble complete warranty 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.

END OF SECTION 01 78 00

**SECTION 01 79 00
DEMONSTRATION AND TRAINING**

PART 1 GENERAL

1.01 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.

1.02 SECTION INCLUDES

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

1.03 RELATED REQUIREMENTS

Section 01 30 00 - Administrative Requirements

Section 01 78 00 - Closeout Submittals

Section 01 91 13 - General Commissioning Requirements

Other Specification Sections: Additional requirements for demonstration and training.

1.04 SUBMITTALS

- A. Draft Training Plans: Owner will designate personnel to be trained; tailor training to needs and skill-level of attendees.

1.05 QUALITY ASSURANCE

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

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 DEMONSTRATION - GENERAL

- A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.
- B. Demonstrations conducted during Functional Testing need not be repeated unless Owner personnel training is specified.
- C. Demonstration may be combined with Owner personnel training if applicable.
- D. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
 - 1. Perform demonstrations not less than two weeks prior to Substantial Completion.

01-17-2022

2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- E. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
 1. Perform demonstrations not less than two weeks prior to Substantial Completion.

3.02 TRAINING - GENERAL

- A. Commissioning Authority will prepare the Training Plan based on draft plans submitted.
- B. Conduct training on-site unless otherwise indicated.
- C. Do not start training until Functional Testing is complete, unless otherwise specified or approved by the Commissioning Authority.
- D. Provide training in minimum two hour segments.
- E. The Commissioning Authority is responsible for determining that the training was satisfactorily completed and will provide approval forms.
- F. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.
- G. Review of Facility Policy on Operation and Maintenance Data: During training discuss:
 1. The location of the O&M manuals and procedures for use and preservation; backup copies.
 2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
 3. Typical uses of the O&M manuals.
- H. Product- and System-Specific Training:
 1. Review the applicable O&M manuals.
 2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
 3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
 4. Provide hands-on training on all operational modes possible and preventive maintenance.
 5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
 6. Discuss common troubleshooting problems and solutions.
 7. Discuss any peculiarities of equipment installation or operation.
 8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
 9. Review recommended tools and spare parts inventory suggestions of manufacturers.
 10. Review spare parts and tools required to be furnished by Contractor.
 11. Review spare parts suppliers and sources and procurement procedures.
- I. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.
- J. Video Recordings: Submit digital video recording of each demonstration and training session for Owner's subsequent use.
 1. Format: DVD Disc.
 2. Label each disc and container with session identification and date.

END OF SECTION 01 79 00

**SECTION 01 91 13
GENERAL COMMISSIONING REQUIREMENTS**

PART 1 GENERAL

1.01 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.

1.02 SECTION INCLUDES

1.03 SCOPE OF COMMISSIONING

- A. Coordinate with the Construction Manager.

1.04 RELATED REQUIREMENTS

Section 01 73 00 - Execution

Section 01 79 00 - Demonstration and Training

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

- A. Provide all standard testing equipment required to perform startup and initial checkout and required Functional Testing; unless otherwise noted such testing equipment will NOT become the property of Owner.
- B. Calibration Tolerances: Provide testing equipment of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified.
- C. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

PART 3 EXECUTION

3.01 COMMISSIONING PLAN

- A. Coordinate with Construction Manager.

3.02 STARTUP PLANS AND REPORTS

- A. Coordinate with Construction Manager.

3.03 PREFUNCTIONAL CHECKLISTS

- A. Coordinate with Construction Manager.

3.04 FUNCTIONAL TESTS

- A. Coordinate with Construction Manager.

3.05 SENSOR AND ACTUATOR CALIBRATION

- A. Coordinate with Construction Manager.

3.06 TEST PROCEDURES - GENERAL

- A. Coordinate with Construction Manager.

END OF SECTION 01 91 13

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**SECTION 02 41 00
SELECTIVE DEMOLITION**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Selective Building Demolition:
 - 1. Selective demolition of interior partitions, systems, and building components designated to be removed.
 - 2. Selective demolition of exterior facade, structures, and components designated to be removed.
 - 3. Protection of portions of building adjacent to or affected by selective demolition.
 - 4. Removal of abandoned utilities and wiring systems.
 - 5. Notification to Owner of schedule of shut-off of utilities which serve occupied spaces.
 - 6. Pollution control during selective demolition, including noise control.
 - 7. Removal and legal disposal of materials.
 - 8. Protection of designated site improvements and adjacent construction.
 - 9. Salvage of designated items.
 - 10. Interruption, capping or removal of utilities as applicable.
- B. Selective Site Demolition:
 - 1. Demolition of designated site improvements including paving, curbing, site walls, and utility structures.
 - 2. Demolition of below-grade foundations and site improvements to depth to avoid conflict with new construction or site work.
 - 3. Removal of hollow items or items which could collapse.
 - 4. Salvage of designated items.
 - 5. Protection of site work and adjacent structures.
 - 6. Disconnection, capping, and removal of utilities.
 - 7. Pollution control during building demolition, including noise control.
 - 8. Removal and legal disposal of materials.
 - 9. Designated site improvements and adjacent construction.
 - 10. Interruption, capping or removal of utilities as applicable.

1.03 RELATED SECTIONS

Division 21 - Fire Suppression
Division 22 - Plumbing
Division 23 - HVAC
Division 26 - Electrical
Division 31 - Earthwork
Division 32 - Exterior Improvements
Division 33 - Utilities

1.04 REFERENCES

29 CFR 1926 - Safety and Health Regulations for Construction Current Edition.
NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations 2022.

1.05 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

- B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.06 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.07 PRE-DEMOLITION CONFERENCE

- A. Pre-Demolition Conference: Conduct conference at Project site.
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - 5. Review areas where existing construction is to remain and requires protection.

1.08 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. Schedule: Submit for approval selective demolition schedule, including schedule and methods for capping utilities to be abandoned and maintaining existing utility service.
- C. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
- D. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- E. Inventory: Submit a list of items to be removed by the Contractor and salvaged for re-use prior to start of demolition.
- F. Pre-demolition Photographs or Video: Submit before Work begins.
- G. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.
- H. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.09 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Company specializing in the type of work required.
 - 1. Minimum of 5 years of documented experience.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before starting demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.10 SEQUENCING

- A. Portion of building immediately adjacent to selective demolition area may be occupied during construction.
- B. Conditions existing at time of inspection for bidding purposes will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Storage or sale of removed items or materials on-site is not permitted.
- E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.11 HAZARDOUS MATERIALS

- A. Hazardous Materials: Hazardous materials are not thought to be present in buildings where selective demolition is occurring.
 - 1. An Asbestos Report is available from the Owner upon request. If there are questions they may be directed to the Owner.
 - a. The Contractors shall examine the report to become aware of locations where hazardous materials are present.
 - 2. Do not disturb hazardous materials or items suspected of containing hazardous materials.
- B. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner.
- C. Hazardous materials will be removed by Owner, under a separate contract, prior to the start of the Work.
- D. SPEC NOTE: Retain subparagraph below if hazardous materials are known to be present. Delete if Owner does not have, or will not provide, material safety data sheets for these materials.
 - 1. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.
 - a. An Asbestos Report is available from the Owner upon request. If there are questions they may be directed to the Owner.
 - 2. The Contractor shall be fully and solely responsible for work involving lead-bearing materials.

1.12 EXISTING WARRANTIES

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties. Notify warrantor before proceeding.
- B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

- A. Record documents of existing construction may be provided by Owner. There is no guarantee that existing conditions are same as those indicated in record documents.
 - 1. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- B. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict.

01-17-2022

Promptly submit a written report to Architect.

- C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
 - 1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- D. Survey of Existing Conditions: Record existing conditions by use of measured drawings and pre-construction photographs.
 - 1. Inventory and record the condition of items to be removed and salvaged. Provide photographs of conditions that might be misconstrued as damage caused by salvage operations.
 - 2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.02 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Comply with requirements for access and protection specified herein.
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
 - 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified herein.
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of selective demolition.

3.03 SELECTIVE DEMOLITION - GENERAL

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
- B. Occupied Spaces: Do not close or obstruct streets, walks, drives or other occupied or used spaces or facilities without the written permission of the Owner and the authorities having jurisdiction. Do not interrupt utilities serving occupied or used facilities without the written permission of the Owner and authorities having jurisdiction. If necessary, provide temporary utilities.
- C. Operations: Cease operations if public safety or remaining structures are endangered. Perform temporary corrective measures until operations can be continued properly.
- D. Demolish and remove existing construction only to the extent required by new construction and as indicated on the Drawings. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

01-17-2022

2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
 5. Maintain adequate ventilation when using cutting torches.
 6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 8. Dispose of demolished items and materials promptly. Remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- E. Existing Items to Remain (ETR): Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition, then reinstalled in their original locations after selective demolition operations are complete.
- F. Hazardous Materials: If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury.
- G. Security: Provide adequate protection against accidental trespassing. Secure project after work hours.
- H. Restoration: Restore finishes of patched areas.

3.04 SALVAGE ITEMS

- A. Items to be Salvaged for Delivery to Owner:
1. Requirements:
 - a. Clean salvaged items.
 - b. Pack or crate items after cleaning. Identify contents of containers.
 - c. Store items in a secure area until delivery to Owner.
 - d. Transport items to Owner's storage area designated by Owner.
 - e. Protect items from damage during transport and storage.
 2. Owner-salvaged items may include:
 - a. Doors and hardware.
 - b. Toilet accessories.
 - c. Light fixtures.
 - d. Plumbing fixtures.
 - e. Decorative elements.
- B. Items to be Salvaged for Reinstallation:
1. Requirements:
 - a. Clean and repair items to functional condition adequate for intended reuse.
 - b. Pack or crate items after cleaning and repairing. Identify contents of containers.
 - c. Protect items from damage during transport and storage.
 - d. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
 2. Items to be salvaged and reinstalled may include:
 - a. Doors and hardware.
 - b. Toilet accessories.

01-17-2022

- c. Light fixtures.
- d. Plumbing fixtures.
- e. Decorative elements.
- f. Furniture, fixtures, and equipment.

3.05 SELECTIVE DEMOLITION - EXISTING UTILITIES & SERVICES

- A. Utilities Requiring Interruption, Capping, or Removal:
 - 1. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
 - a. Protect existing utilities to remain from damage.
 - b. Do not disrupt public utilities without permit from authority having jurisdiction.
 - 2. Do not close, shut off, or disrupt existing life safety systems that are in use without prior written notification to Owner.
 - 3. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without prior written notification to Owner.
 - 4. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- B. Services: Remove existing systems and equipment as indicated.
 - 1. Services include, but not limited to, HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications):
 - a. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 - b. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - c. Verify that abandoned services serve only abandoned facilities before removal.
 - 2. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.
 - 3. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.
- C. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.

3.06 DEBRIS AND WASTE REMOVAL

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them. Use of an EPA-approved landfill shall be required if materials include such items that require that type of landfill.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 4. Provide Landfill Receipts indicating proper disposal of all hazardous materials disposed of by the Contractor.
- B. Burning: Do not burn demolished materials on-site.
- C. Leave site in clean condition, ready for subsequent work.
- D. Clean up spillage and wind-blown debris from public and private lands.

3.07 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition

operations began.

3.08 SCHEDULE OF ITEMS TO BE SALVAGED FOR REINSTALLATION

- A. Coordinate with Architect prior to the starting of the selective demolition Work.

3.09 SCHEDULE OF ITEMS TO BE SALVAGED AND DELIVERED TO OWNER

- A. Coordinate with Owner prior to the starting of the selective demolition Work.

END OF SECTION 02 41 00

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SECTION 03 30 00
CAST-IN-PLACE CONCRETE

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 SECTION INCLUDES

- A. Cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Floor levelness and floor flatness requirements.

1.03 RELATED REQUIREMENTS

- A. Section 03 05 05 - Underslab Vapor Barrier
- B. Section 03 30 06 - Concrete Moisture Vapor Reduction Admixture (MVRA)
- C. Section 04 26 00 - Single-Wythe Unit Masonry
- D. Section 07 21 00 - Thermal Insulation
- E. Section 31 31 16 - Chemical Soil Treatment

1.04 DEFINITIONS

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

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.
- E. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturer and testing agency.
- B. Welding certificates.
- C. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Form materials and form-release agents.
 - 4. Steel reinforcement and accessories.
 - 5. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- D. Field quality-control reports.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
 - 1. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
- C. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- D. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
 - 1. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
 - 2. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."
 - 3. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
- E. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
- F. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- H. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - 1. Contractor's superintendent.
 - 2. Independent testing agency responsible for concrete design mixtures.
 - 3. Ready-mix concrete manufacturer.
 - 4. Concrete subcontractor.
- I. Review special inspection and testing and inspecting agency procedures for field quality control, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, joint-filler strips, forms and form removal limitations, shoring and reshoring procedures, anchor rod and anchorage device installation tolerances, steel reinforcement installation, concrete repair procedures, and concrete protection.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

PART 2 PRODUCTS

2.01 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
- B. Plywood, metal, or other approved panel materials.
- C. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - 1. High-density overlay, Class 1 or better.
 - 2. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
 - 3. Structural 1, B-B or better; mill oiled and edge sealed.
 - 4. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

- a. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
 - b. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.
 - c. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
 - d. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- D. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- 1. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
- E. Furnish units that will leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
- F. Furnish ties that, when removed, will leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
- G. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.02 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/ A615M, Grade 60 (Grade 420), deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A706/ A706M, deformed.
- C. Steel Bar Mats: ASTM A 184/ A184M, fabricated from ASTM A615/ A615M, Grade 60 (Grade 420), deformed bars, assembled with clips.
- D. Plain-Steel Wire: ASTM A82/ A82M, as drawn.
- E. Deformed-Steel Wire: ASTM A 96/ A496M.

2.03 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/ A615M, Grade 60 (Grade 420), plain-steel bars, cut true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

2.04 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
- B. Portland Cement: ASTM C150, Type I or II, gray. Supplement with the following:
 - 1. Fly Ash: ASTM C 618, Class C or F.
 - a. Normal-Weight Aggregates: ASTM C33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
- C. Maximum Coarse-Aggregate Size: 1-1/2 inches (38 mm) for mass pouring at piers only and 3/4 inch (19 mm) nominal typically.
- D. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
 - 1. Water: ASTM C94/ C94M and potable.

2.05 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C260.

- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
- C. Water-Reducing Admixture: ASTM C494/ C494M, Type A.
- D. Retarding Admixture: ASTM C494/ C494M, Type B.
- E. Water-Reducing and Retarding Admixture: ASTM C494/ C494M, Type D.
- F. High-Range, Water-Reducing Admixture: ASTM C494/ C494M, Type F.
- G. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/ C494M, Type G.
- H. Plasticizing and Retarding Admixture: ASTM C1017/ C1017M, Type II.

2.06 UNDERSLAB VAPOR BARRIER

- A. Plastic Vapor Retarder: ASTM E 1745, Class A, with a maximum permance of 0.01 perms. Include manufacturer's recommended adhesive or pressure-sensitive tape.
 - 1. Available Products:
 - a. Stego Industries, LLC; Stego Wrap 15 mil
- B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

2.07 DRAINAGE LAYER BELOW SLAB-ON-GRADE

- A. A 4-inch minimum layer of open-graded gravel, conforming to ASTM C33/C33M No. 57, shall be placed on the prepared subgrade as the future base for the building addition slab-on-grade.

2.08 LIQUID FLOOR TREATMENTS

- A. VOC Content: Liquid floor treatments shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.
- C. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. ChemMasters; Chemisil Plus.
 - 2. ChemTec Int'l; ChemTec One.
 - 3. Conspec by Dayton Superior; Intraseal.
 - 4. Curecrete Distribution Inc.; Ashford Formula.
 - 5. Dayton Superior Corporation; Day-Chem Sure Hard (J-17).

2.09 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BASF Construction Chemicals - Building Systems; Confilm.
 - b. ChemMasters; SprayFilm.
 - c. Conspec by Dayton Superior; Aquafilm.
 - d. Dayton Superior Corporation; Sure Film (J-74).
 - e. Edoco by Dayton Superior; BurkeFilm.
 - f. Euclid Chemical Company (The), an RPM company; Eucobar.

- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anti-Hydro International, Inc.; AH Clear Cure WB.
 - b. BASF Construction Chemicals - Building Systems; Kure-N-Seal WB.
 - c. ChemMasters; Safe-Cure & Seal 20.
 - d. Conspec by Dayton Superior; Cure and Seal WB.
 - e. Cresset Chemical Company; Crete-Trete 309-VOC Cure & Seal.

2.10 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.
- B. Bonding Agent: ASTM C1059/ C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

2.11 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C150, portland cement as defined in ASTM C219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 4100 psi (29 MPa) at 28 days when tested according to ASTM C109/ C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6.4 mm) and that can be filled in over a scarified surface to match adjacent floor elevations.

2.12 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
- B. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
 - 1. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
- C. Fly Ash: 15 percent.
- D. Combined Fly Ash and Pozzolan: 15 percent.
 - 1. Limit water-soluble, chloride-ion content in hardened concrete to 0.25 for exterior concrete and 1.00 percent by weight of cement for all interior concrete.
 - 2. Admixtures: Use admixtures according to manufacturer's written instructions.
- E. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.

- F. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- G. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
- H. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

2.13 CONCRETE MIXES FOR BUILDING ELEMENTS

- A. A. Footings: Proportion normal-weight concrete mixture as follows:
 - 1. Minimum Compressive Strength: 3500 psi (24.1 MPa) at 28 days.
 - 2. Minimum Cementitious Materials Content: 500 lb/cu. yd.
 - 3. Maximum Water-Cementitious Materials Ratio: 0.499.
 - 4. Slump Limit: 4 inches (100 mm), plus or minus 1" max.
- B. Interior Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:
 - 1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
 - 2. Minimum Cementitious Materials Content: 550 lb/cu. yd.
 - 3. Maximum Water-Cementitious Materials Ratio: 0.46.
 - 4. Slump Limit: 4 inches (100 mm), plus or minus 1" max.
- C. Exterior Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:
 - 1. Minimum Compressive Strength: 4500 psi (27.6 MPa) at 28 days.
 - 2. Minimum Cementitious Materials Content: 560 lb/cu. yd.
 - 3. Maximum Water-Cementitious Materials Ratio: 0.42.
 - 4. Slump Limit: 4 inches (100 mm), plus or minus 1" max.
 - 5. 6% +/- 1% air-entrainment.
- D. Elevated Rooftop RTU Slab: Proportion Light-weight concrete mixture as follows:
 - 1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
 - 2. Maximum Dry Density = 115 lb/cu. ft. +/- 3 lbs/cu. ft.
 - 2. Minimum Cementitious Materials Content: 660 lb/cu. yd.
 - 3. Maximum Water-Cementitious Materials Ratio: 0.42.
 - 4. Slump Limit: 4 inches (100 mm), plus or minus 1" max.
 - 5. 5.5% +/- 0.5% air-entrainment.

2.14 FABRICATING REINFORCEMENT

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

2.15 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
- B. On Project Site: Mix in drum type batch mixer, complying with ASTM C685/C685M. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.
 - 1. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 EXECUTION

3.01 PREPARATION

- A. Coordinate the concrete work with the chemical treatment of the soil under the building pad. Refer to Section 31 31 16 - Chemical Soil Treatment, for requirements.

3.02 UNDERSLAB VAPOR BARRIER

- A. Refer to Section 03 05 05 - Underslab Vapor Barrier, for requirements.

3.03 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch (3.2 mm) for smooth-formed finished surfaces.
 - 2. Class B, 1/4 inch (6 mm) for rough-formed finished surfaces.
 - a. Construct forms tight enough to prevent loss of concrete mortar.
 - b. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
- D. Install keyways, reglets, recesses, and the like, for easy removal.
- E. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.04 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- B. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- C. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
- D. Install dovetail anchor slots in concrete structures as indicated.

3.05 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
- B. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- C. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- D. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- E. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.
- F. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- G. Install flat sheet welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.06 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. At floor areas to be constructed with moisture migration inhibitor admixture materials, manufacturers rep shall be contacted and scheduled to be present for concrete pours at the mix plant and on site to monitor proper dosage, water management and finishing techniques for this material.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
- E. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- F. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
- G. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
- H. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 - 1. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- I. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
- J. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
- K. Maintain reinforcement in position on chairs during concrete placement.
- L. Screed slab surfaces with a straightedge and strike off to correct elevations.
- M. Slope surfaces uniformly to drains where required.

- N. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- O. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- P. Hot-Weather Placement: Comply with ACI 301 and as follows:
 - 1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

3.07 SLAB JOINTING

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
- C. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
- D. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
- E. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
- F. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
- G. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- H. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 - 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
 - 2. Terminate full-width joint-filler strips not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants occur.
 - 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
 - 4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.08 FLOOR FLATNESS AND LEVELNESS REQUIREMENTS

- A. Definitions:

1. Floor Levelness (FL): The FL number relates to the general floor slope of a concrete floor from an assumed datum elevation.
 - a. Elevation differences are measured every 10-feet within 72 hours after the concrete is placed and those measurements are entered into a calculation to determine floor levelness.
 - b. FL numbers generally only apply to slabs-on-grade.
 - c. FL numbers are only specified on elevated slabs when measurements are taken before shores and forms are removed and the slab has no camber.
 2. Floor Flatness (FF): The FF number relates to the rate of change of the elevation of a concrete floor.
 - a. Elevation differences are taken every foot within 72 hours after the concrete is placed and a formula determines the FF measurement.
 3. Specified Overall Values (SOV): The SOV number provides criteria for the entire project through average FF and FL values for all concrete floors on the project.
 4. Minimum Local Values (MLV): The MLV number provides criteria for the minimum allowable FF and FL values for each section of concrete placed (or for each "pour") on a project, below which repair or replacement is required.
- B. Finish Floors to the tolerances specified, in accordance ACI 302.1, ACI 117, and ASTM E1155:
1. Slabs-on-Grade (SOG):
 - a. Concrete floor areas exposed to view, without floorcoverings:
 - 1) Surface Profile: Conventional (using bullfloat)
 - 2) Floor Flatness (FF): SOV of 20, MLV of 13
 - 3) Floor Levelness (FL): SOV of 15, MLV of 10
 - 4) Application: Non-critical spaces, mechanical rooms, back-of-house (non-public) areas, and parking garage slabs
 - 5) Building Use: General office, light industrial, and commercial buildings
 - b. Concrete floor areas not exposed to view:
 - 1) Surface Profile: Conventional (using bullfloat)
 - 2) Floor Flatness (FF): SOV of 20, MLV of 13
 - 3) Floor Levelness (FL): SOV of 15, MLV of 10
 - 4) Application: Areas under raised access flooring.
 - 5) Building Use: General office, light industrial, and commercial buildings
 - c. Concrete floor areas under carpeting:
 - 1) Surface Profile: Conventional (using highway straightedge)
 - 2) Floor Flatness (FF): SOV of 25, MLV of 17
 - 3) Floor Levelness (FL): SOV of 20, MLV of 15
 - 4) Building Use: General office, light industrial, and commercial buildings
 - d. Concrete floor areas under thin-set tile, resilient flooring, and other thin flooring materials:
 - 1) Surface Profile: Flat
 - 2) Floor Flatness (FF): SOV of 35, MLV of 24
 - 3) Floor Levelness (FL): SOV of 25, MLV of 17
 - 4) Building Use: General office, light industrial, and commercial buildings
 2. Elevated Slabs:
 - a. Match surface profile, FF values, of slabs-on-grade conditions noted above. FL values need not be taken.
- C. Correct the slab surface if composite overall value is less than specified and if local value is less than two-thirds of specified value or less than $F(F) \ 13/F(L) \ 10$.
- D. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

3.09 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces to receive trowel finish.
- C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
- D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated and where Terrazzo or Porcelain tile is to be installed by thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
- E. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

3.10 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- C. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.11 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Cure concrete according to ACI 308.1.
 - 1. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with a moisture-retaining cover.
- D. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat

areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.12 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
- B. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
- C. Do not apply to concrete that has not completed the minimum manufacturers recommended curing time.
- D. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
 - 1. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.13 JOINT FILLER

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

3.14 CONCRETE SURFACE REPAIRS

- A. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.
- B. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
- C. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
- D. After concrete has cured at least 14 days, correct high areas by grinding.
- E. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
- F. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
- G. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
- H. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar

before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

1. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
2. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

- A. Special Inspections: Owner shall engage the services of a special inspector to perform special inspections required by Section 01 45 33 - Code-Required Special Inspections, and prepare field reports.
- B. The Contractor will engage an independent testing agency to perform field quality control tests, as specified in Section 01 45 33 - Code-Required Special Inspections.
 1. General:
 - a. Provide free access to concrete operations at project site and cooperate with appointed firm.
 - b. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
 - c. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.
 2. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:
 - a. Compressive Strength Tests: ASTM C39/C39M. For each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cubic yards or less of each class of concrete placed. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
 - b. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
 - c. Slump Tests: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - d. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - e. Concrete Temperature: ASTM A1064/A1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
 - f. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - g. Compression Test Specimens: ASTM C31/C31M.
 - 1) A set of test cylinders shall consist of a minimum of four standard cylinder specimens for each composite sample. The number per set may be greater depending on the cylinder sizes.
 - h. Compressive-Strength Tests: ASTM C39/C39M; test one cylinder of the laboratory-cured specimens at 7 days and one set of at least two cylinders at 28 days.
 - 1) Test one cylinder of a set at 7 days and one set of two 6" by 12" cylinders at 28 days.
 - 2) One cylinder shall be retained in reserve to be tested as directed by the Engineer.
 - 3) A compressive-strength test shall be the average compressive strength from a set of at least two cylinders obtained from the same composite sample and tested at age indicated.
- C. Test Results:

1. Test results shall be reported in writing to Architect, concrete manufacturer, and Subcontractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
 2. Non-destructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- D. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
- E. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.
- F. Testing of Slabs containing MVRA:
1. The moisture vapor reduction admixture (MVRA) manufacturer will perform all moisture testing in accordance with this specification and will issue project specific warranties prior to installation of any slab finishes; no further field slab moisture nor pH testing shall be required.
 - a. Failure to provide a product that meets or exceeds these requirements will result in all subsequent testing and slab remediation costs being borne by the Subcontractor.

3.16 DEFECTIVE CONCRETE

- A. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.
- B. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- C. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

3.17 PROTECTION OF LIQUID FLOOR TREATMENTS

- A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION

SECTION 03 30 30
CONCRETE WORK - PATCHING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Furnishing of all necessary materials, labor and equipment, mixing, placing and furnishing of all plain and reinforced concrete for patching of existing concrete floor slabs for Work indicated on the drawings.

1.03 RELATED SECTIONS

Section 02 41 00 - Selective Demolition

1.04 REFERENCES

- A. Comply with the requirements of the following codes, specifications, and standards. When the provisions of this section differ from the referenced codes, specifications, and standards the provisions of this section shall govern. Comply with local building code requirements that are more stringent than those specified herein.
- B. ACI 302 "Recommended Practice for Concrete Floor and Slab Construction
- C. ACI 304 "Recommended Practice for Measuring, Mixing, and Placing Concrete"
- D. CRSI "Manual of Standard Practice"
- E. ASTM C33/C33M "Standard Specification for Concrete Aggregates"
- F. ASTM C94/C94M "Standard Specification for Ready-Mixed Concrete"
- G. ASTM C150/C150M "Standard Specification for Portland Cement"
- H. ASTM A1064/A1064M "Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete"

1.05 SUBMITTALS

- A. Concrete Mix Designs: Submit proposed concrete mix design.
 - 1. Indicate proposed mix design complies with requirements of ACI 301, Section 4 - Concrete Mixtures.
 - 2. Indicate proposed mix design complies with requirements of ACI 318, Chapter 5 - Concrete Quality, Mixing and Placing.
- B. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Steel reinforcement and accessories.
 - 3. Waterstops.
 - 4. Joint-filler strips.
- C. Test Reports
- D. See individual paragraphs this section for requirements.

1.06 QUALITY ASSURANCE

- A. Contractor shall be qualified/experienced in concrete patching of this type.
- B. Comply with governing codes and regulations.

1.07 CONCRETE TESTING

- A. Not required.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

- A. Portland Cement: Conforming to ASTM C150/C150M, Type I or III.
- B. Aggregates: Shall conform to the standard specifications for concrete aggregates (ASTM C33/C33M) with all subsequent amendments thereto.
 - 1. Coarse Aggregate: Clean, hard, durable, uncoated, crushed limestone conforming to the quality and gradation requirements of ASTM C33/C33M. Maximum size aggregate allowed shall be 3/4" for construction less than 6" in thickness.
 - a. Coarse Aggregate for lightweight concrete shall conform to ASTM C330/C330M.
 - 2. Fine Aggregate: Shall conform to ASTM C33/C33M.
- C. Water: Shall be clean and free from deleterious substances, oils, acids, alkalis, or organic materials.
- D. Admixtures: Not required.

2.02 GRANULAR FILL

- A. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D448, Size 57, with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve placed below the vapor retarder.
 - 1. Install and compact at 4 inches minimum depth, unless otherwise indicated on the Drawings.

2.03 JOINTING PRODUCTS

- A. Slab Expansion and Isolation Joint Filler Strips: 1/2 inch (13 mm) thick, height equal to slab thickness, with removable top section that will form 1/2 inch (13 mm) deep sealant pocket after removal.
 - 1. Material: ASTM D1751, cellulose fiber.

2.04 REINFORCING

- A. All bars shall be billet steel conforming to ASTM A615/A615M, grade 60 steel for #5 bars and greater and grade 40 steel for #4 and under.
- B. Reinforcing Accessories;
 - 1. Joint Dowel Bars: ASTM A615/A615M, Grade 60 (Grade 420), plain-steel bars, cut bars true to length with ends square and free of burrs.
 - 2. Bar Supports: Bolsters, spacers, chairs, ties, and other devices necessary for properly placing, spacing, supporting and fastening reinforcement in place shall be used according to the latest edition of the Concrete Reinforcing Steel Institute Manual.

PART 3 EXECUTION

3.01 CONCRETE QUALITY

- A. The Contractor shall guarantee concrete with the following minimums
 - 1. Cast-in-place structural concrete shall be 3,500 psi design strength using not less than 500 pounds of cement per cubic yard and not more than 6 gallons of water per 100 pounds of cement with aggregate specified.
- B. Normal Weight Concrete
 - 1. Shall be used throughout the project (structural and non-structural).
 - 2. Prior to placing any concrete, the Contractor shall submit for review by the Architect a mix design for each type of concrete proposed for use by each concrete supplier, substantiated by a laboratory report attesting to the concrete properties, including compressive strength and splitting strength.
 - 3. Upon approval, the Contractor shall not change suppliers except upon written authorization by the Architect.
- C. Mixing Concrete
 - 1. The concrete shall be mixed until there is a uniform distribution of the materials and shall be discharged completely before the mixer is recharged.

01-17-2022

2. Ready-mixed concrete shall be mixed and delivered in accordance with ASTM C94/C94M with all subsequent amendments thereto.
3. Maximum Slump: 4".
- D. Placing Concrete
 1. Placement shall be planned well in advance so that all sections of a particular area may be poured in one continuous operation.
 2. Before Concrete is placed, all debris and foreign material shall be removed from the area to be poured. All reinforcing and any special metal parts or shapes shall be properly set into position.
 3. Transporting: Concrete shall be handled from carts, buggies, or wheelbarrows. Every possible precaution shall be taken to prevent separation or loss of the ingredients while transporting the concrete.
 4. Placing: Troughs, Pipes and Chutes
 - a. Concrete shall not be dropped freely a distance of more than five (5) feet.
 - b. Placing of any given section shall be done in a continuous operation.
- E. Extra water shall not be added to the concrete mix at the job site.
- F. Placing Time:
 1. The elapsed time between proportioning of materials, including cement, and placing of concrete in its final position shall never exceed 90 minutes.
 2. Concrete shall never remain on the job site for more than 60 minutes without being placed.

3.02 BENDING AND PLACING REINFORCING STEEL

- A. Cleaning and Bending Reinforcement:
 1. Metal reinforcement, at the time concrete is placed shall be free from rust, scale or other coatings that will destroy or reduce the bond.
 2. Bends for other bars shall be made around a pin having a diameter of not less than six times the minimum thickness of the bar except that for bars larger than 1 inch, the pin shall be not less than eight times the minimum thickness of the bar.
 3. All bars shall be bent cold.
- B. Placing Reinforcement:
 1. Metal reinforcement shall be accurately placed in accordance with the Drawings and shall be adequately secured in position by concrete or metal chairs and spacers.

3.03 FINISHING

- A. Flatwork slabs shall be poured monolithic, leveled with a straight edge screed in a sawing motion of a strike-off board.
 1. Finish to match existing/adjacent concrete surfaces.
 2. Interior slabs, shall be floated and finished with steel trowel.
 3. Floating shall not start until water sheen has disappeared or concrete has stiffened enough to prevent excess fine material working to the surface.

3.04 TOLERANCES:

- A. Allowable tolerance from level or grade shall be 1/4" in 10 feet measured with a straight edge in any direction.

END OF SECTION 03 30 30

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**SECTION 04 20 00
BRICK AND CONCRETE MASONRY**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Face brick.
- B. Mortar and grout.
- C. Joint reinforcement.
- D. Ties and anchors.
- E. Flashing.
- F. Cavity Protection.
- G. Miscellaneous masonry accessories.
- H. Products Installed but not Furnished under This Section:
 - 1. Cast-stone trim in unit masonry.
 - 2. Steel lintels in unit masonry.
 - 3. Steel shelf angles for supporting unit masonry.
 - 4. Cavity wall insulation.

1.03 RELATED SECTIONS

- A. Section 07 62 00 - Sheet Metal Flashing and Trim
- B. Section 07 84 00 - Firestopping.
- C. Section 07 92 00 - Joint Sealants.

1.04 REFERENCES

- A. ASTM A951/A951M - Standard Specification for Steel Wire for Masonry Joint Reinforcement 2016, with Editorial Revision (2018).
- B. ASTM C1019 - Standard Test Method for Sampling and Testing Grout for Masonry 2020.
- C. ASTM C1088 - Standard Specification for Thin Veneer Brick Units Made From Clay or Shale 2020.
- D. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens) 2021.
- E. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete 2020.
- F. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete 2019.
- G. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation 2019.
- H. ASTM D1056 - Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber 2020.
- I. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness 2015 (Reapproved 2021).
- J. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension 2016 (Reapproved 2021).
- K. ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers 2000 (Reapproved 2020).
- L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- M. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures 2016.

01-17-2022

- N. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- O. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire 2019.
- P. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2018a.
- Q. ASTM C67 - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile 2017.
- R. ASTM C91/C91M - Standard Specification for Masonry Cement 2018.
- S. ASTM C140/C140M - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units 2021.
- T. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar 2018.
- U. ASTM C150/C150M - Standard Specification for Portland Cement 2021.
- V. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes 2018.
- W. ASTM C216 - Standard Specification for Facing Brick (Solid Masonry Units Made From Clay or Shale) 2021.
- X. ASTM C270 - Standard Specification for Mortar for Unit Masonry 2019a.
- Y. ASTM C387/C387M - Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar 2017.
- Z. ASTM C404 - Standard Specification for Aggregates for Masonry Grout 2018.
- AA. ASTM C476 - Standard Specification for Grout for Masonry 2020.
- BB. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry 2020.
- CC. ASTM C1088
- DD. ASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete 2016.
- EE. ASTM D226/D226M - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing 2017.
- FF. ASTM E514/E514M - Standard Test Method for Water Penetration and Leakage Through Masonry 2020.
- GG. BIA Technical Notes No. 7 - Water Penetration Resistance – Design and Detailing 2017.
- HH. BIA Technical Notes No. 28B - Brick Veneer/Steel Stud Walls 2005.
- II. BIA Technical Notes No. 46 - Maintenance of Brick Masonry 2017.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by all relevant installers.

1.06 SUBMITTALS

- A. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.
- B. Samples: Submit samples of block units to illustrate color, texture, and extremes of color range. Verify quantity of samples with Architect.
- C. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.
- D. Manufacturer's Certificate: Certify that water repellent admixture manufacturer has certified masonry unit manufacturer as an approved user of water repellent admixture in the manufacture of concrete block.

- E. Test Reports: Concrete masonry manufacturer's test reports for units with integral water repellent admixture.
- F. 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 C 1506 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.
- G. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.07 QUALITY ASSURANCE

- A. Comply with provisions of TMS 402/602, except where exceeded by requirements of the contract documents.
- B. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with minimum five years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with at least five years of documented experience.
- D. Masonry Design Methods:
 - 1. Masonry shall comply with the provisions of TMS 402/ACI 530/ASCE 5 or TMS 403, including the following parameters:
 - a. Engineered Design.
 - b. Essential Facility.
 - c. Risk Category: III.
 - d. Quality Assurance Level: B.
- E. Special Inspection and Testing:
 - 1. Per Paragraph 1705.4 of the 2015 International Building Code, special inspections and testing of masonry construction shall be performed in accordance with the quality assurance program requirements of TMS 402/ACI 530/ASCE 5 and TMS 602/ACI 530.1/ASCE 6.

1.08 MOCK-UP

- A. Metal Stud and Veneer Wall Mock-up: Build mock-up of a typical exterior metal stud-veneer wall section. Mock-up shall include metal stud framing, sheathing, thermal insulation, brick veneer, veneer anchors, flashings, cavity protection material, weep holes, and sealant, etc. for a complete representation of the wall construction.
- B. Mock-up Panel Size: 6-feet long by 6-feet high by full thickness.
 - 1. Mock-up shall include a 24-inch wide by 24-inch high window opening, complete with a aluminum storefront framing and glazing.
- C. Refer to drawings for mock-up panel requirements.
- D. Clean one-half of exposed faces of mockups with masonry cleaner.
- E. Once completed, protect the mock-panel from the elements with weather-resistant membrane.
- F. Locate mock-up panel where directed. Build mock-up panel facing south.
- G. Approval of mock-up panel is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities indicated.
 - 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
- H. Mock-up may remain as part of the Work.

1.09 DELIVERY, STORAGE, AND HANDLING

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

1.10 JOB CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls and hold cover securely in place.
- B. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- C. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 PRODUCTS

2.01 MASONRY UNITS, GENERAL

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

2.02 FACE BRICK

- A. Manufacturer
 - 1. Specified Manufacturer: Acme Brick.
 - a. Other Acceptable Manufacturer: None identified. No substitutions will be considered or accepted.
- B. Face Brick: ASTM C216, Type FBX, Grade SW.
 - 1. Nominal Size: Modular.
 - 2. Texture: Velour.
 - 3. Color: Garnet.
 - 4. Performance:
 - a. Unit Compressive Strength: 2500 psi, minimum Grade SW.
 - b. Maximum Water Absorption 5-Hr Boiling: 20-percent, per ASTM C67.
 - c. Efflorescence: Provide brick that has been tested according to ASTM C67 and is rated "not effloresced."
 - 5. Coarsing: Running bond.
 - 6. Size (Actual Dimensions):
 - a. Modular: 7 5/8-inches long by 2 1/4-inches high by 3 5/8-inches deep.

- b. Utility: 11 5/8-inches long by 3 5/8-inches high by 3 5/8-inches deep.
- c. Norman: 11 5/8-inches long by 2 1/4-inches high by 3 5/8-inches deep.
- d. Monarch: 15 5/8-inches long by 3 5/8-inches high by 3 5/8-inches deep.
- e. Ambassador: 15 5/8-inches long by 2 1/4-inches high by 3 5/8-inches deep.

2.03 MORTAR AND GROUT MATERIALS

A. Manufacturers:

1. Mortar and Grout:

- a. Specified Manufacturer: Amerimix Companies
 - 1) Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be acceptable.
 - (a) SPEC MIX® (Web: www.specmix.com)
 - (b) The QUIKRETE Companies (Web: www.quikrete.com)
 - (c) Sakrete (Web: www.sakrete.com)
 - (d) Empire Blended Products (Web: www.empireblended.com)
 - (e) TCC Materials (Web: www.tccmaterials.com)
 - (f) Roman Cement Mixes (Web: www.romacementmixes.com)

2. Pigments for Colored Mortar:

- a. Products of the manufacturer's listed below will be acceptable:
 - 1) Solomon Colors, Inc.
 - 2) Davis Colors: True Tone.
 - 3) Lanxess Corporation.

B. Materials:

- 1. Portland Cement: ASTM C150/C150M, Type I.
 - a. Not more than 0.60-percent alkali.
 - b. Provide natural color or white cement as required to produce mortar color indicated.
- 2. Hydrated Lime: ASTM C207, Type S.
- 3. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- 4. Masonry Cement: ASTM C91/C91M.
- 5. Mortar Cement: ASTM C1329/C1329M.
- 6. Mortar Aggregate: ASTM C144.
- 7. Grout Aggregate: ASTM C404.
- 8. Water shall be clean and free from deleterious amounts of acids, alkalis or organic material.
- 9. Sand shall be clean, natural sand conforming to ASTM C144, Loam content not to exceed 5% by volume.
- 10. Pigments for Colored Mortar (if applicable): Pure, concentrated mineral pigments specifically intended for mixing into mortar and complying with ASTM C979/C979M.

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

- 1. Product: Products of the manufacturer's listed below will be acceptable.
 - a. BASF Corporation.
 - b. Euclid Chemical Company.
 - c. W.R. Grace & Company.

D. Water Repellent Admixture for Mortar: Polymeric liquid admixture added to mortar at the time of manufacture.

- 1. Product: "RainBloc GP" by Amerimix Companies.
 - a. Use only in combination with masonry units manufactured with integral water repellent admixture.
 - b. Use only water repellent admixture for mortar from the same manufacturer as water repellent admixture in masonry units.

01-17-2022

- c. Meet or exceed performance specified for water repellent admixture used in masonry units.
- d. Compliance:
 - 1) Water Permeance of Masonry, ASTM E514/E514M: Class E.
 - 2) Admixture Classification: Capable of meeting all of the requirements for a Water Repellent Classification when evaluated in accordance with ASTM C1384.
- E. Portland Cement Mortars:
 - 1. Pre-Blended Mortar for Unit Masonry: Factory blend of portland cement, hydrated lime, and dried sand; complying with ASTM C387/C387M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
 - a. Product: "AMX 400" as manufactured by Amerimix Companies (Oldcastle).
 - 1) Type: Type N, Type S, or Type M as scheduled in this Section.
 - 2) Pigment: Standard pigment color; compliant with ASTM C979.
 - 2. Pre-Blended, Water Repellent Mortar for Unit Masonry: Factory blend of portland cement, hydrated lime, dried sand, water repellent, and proprietary admixtures; complying with ASTM C387/C387M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
 - a. Product: "AMX 410 WRM" as manufactured by Amerimix Companies (Oldcastle).
 - 1) Description: Water-repellent mortar for use with water repellent masonry units.
 - 2) Type: Type N, Type S, or Type M as scheduled in this Section.
 - 3) Pigment: Standard pigment color; compliant with ASTM C979.
- F. Masonry Cement Mortars:
 - 1. Pre-Blended Masonry Cement Mortar for Brick Masonry: Factory blend of masonry cement, dried sand, and a formulation for water retention, workability and bond strength; complying with ASTM C387/C387M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
 - a. Product: "AMX 500" as manufactured by Amerimix Companies (Oldcastle).
 - 1) Type: Type N, Type S, or Type M as scheduled in this Section.
 - 2) Pigment: Standard pigment color; compliant with ASTM C979.
 - (a) Color: To be selected by Architect from manufacturer's standard colors.
 - 3) Compliance:
 - (a) Color pigment complies with ASTM C979.
 - (b) Meets ACI 530 code and ICC requirements for masonry mortars.
 - 2. Pre-Blended, Water Repellent Masonry Cement Mortar for Brick Masonry: Factory blend of masonry cement, sand, water repellent and proprietary admixtures; complying with ASTM C387/C387M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
 - a. Product: "AMX 510 WRM" as manufactured by Amerimix Companies (Oldcastle).
 - 1) Type: Type N, Type S, or Type M as scheduled in this Section.
 - 2) Pigment: Standard pigment color; compliant with ASTM C979.
 - (a) Color: To be selected by Architect from manufacturer's standard colors.
 - 3) Compliance:
 - (a) Color pigment complies with ASTM C979.
 - (b) Meets ACI 530 code and ICC requirements for masonry mortars.
 - 3. Pre-Blended, Colored Masonry Cement Mortar for Brick Masonry: Factory blend of masonry cement, mason's sand, and colored pigment formulation; complying with ASTM C387/C387M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
 - a. Product: "AMX 505C" as manufactured by Amerimix Companies (Oldcastle).
 - 1) Type: Type N, Type S, or Type M as scheduled in this Section.
 - 2) Pigment: Standard pigment color; compliant with ASTM C979.
 - (a) Color: To be selected by Architect from manufacturer's standard colors.
 - 3) Compliance:
 - (a) Color pigment complies with ASTM C979.

(b) Meets ACI 530 code and ICC requirements for masonry mortars.

G. Grout:

1. Packaged Dry Material for Grout for Masonry: Premixed cementitious materials and dried aggregates; capable of producing grout of the specified strength in accordance with ASTM C476 with the addition of water only.
 - a. Product: Amerimix; "AMX 600CG Pre-Blended Core Fill Grout - Coarse"
 - 1) Type: Coarse.
 - 2) Compliance:
 - (a) Meets or exceed ASTM C476.
 - (b) Meets ACI 530 (Table 7) code and ICC requirements for masonry grout.

2.04 MORTAR AND GROUT MIXES

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

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime 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.
6. For exterior masonry, use integral water repellant admixture.

B. Mortar for Unit Masonry:

1. Mortar Types: Mortar shall comply with ASTM C270 with type as specified below:
 - a. Type 'N' Mortar:
 - 1) Mix Design: Mixed by volume, one (1) part Portland Cement, 1-1/4 parts lime, and six (6) parts sand.
 - 2) Applications:
 - (a) For other applications where another type is not indicated.
 - b. Type 'S' Mortar:
 - 1) Mix Design: Mixed by volume, one (1) part Portland Cement, 1/2 parts lime, and four and one-half (4-1/2) parts sand.
 - 2) Applications:
 - (a) For exterior, below-grade, load-bearing and nonload-bearing walls.
 - (b) For other applications where another type is not indicated.
2. 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.
3. Colored Mortar: Use pigments for colored mortar as described in this section.

C. Grout for Unit Masonry: ASTM C476; consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches (50 mm) or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches (50 mm).

1. Mix Design:
 - a. Portland Cement: 1 part.
 - b. Hydrate Lime: 0 to 1/10 part.
 - c. Coarse Aggregate (Volume): Measured damp and loose: 1 to 2 times the sum of the separate volumes of cementitious materials.
2. Provide grout with a slump of 8-inches to 11-inches (203 to 279 mm) as measured according to ASTM C143/C143M.
3. See Structural Drawings for minimum required compressive grout strengths.

2.05 JOINT REINFORCEMENT AND ANCHORAGE

A. Manufacturers:

1. Specified Manufacturer: Hohmann & Barnard, Inc (H-B)

- a. Contact: P: 800-645-0616 / Web: www.h-b.com
2. Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be acceptable.
 - a. Blok-Lok Limited .
 - b. AA Wire Products.
 - c. Wire-Bond.
 - d. National Wire Products Corp.
- B. Masonry Wall Joint Reinforcement, General: ASTM A951/A951M.
- C. Single-Wythe Masonry Wall Joint Reinforcement:
 1. Ladder type; ASTM A1064/A1064M steel wire, mill galvanized to ASTM A641/A641M, Class 3; 0.1483 inch (3.8 mm) side rods with 0.1483 inch (3.8 mm) cross rods; width as required to provide not more than 1 inch (25 mm) and not less than 1/2 inch (13 mm) of mortar coverage on each exposure.
 - a. Application: Masonry walls with vertical reinforcement.
 - b. Product: H-B; #220 Ladder Mesh Reinforcement.
 - 1) Provide pre-fabricated corners and tees.
 2. Truss type; ASTM A1064/A1064M steel wire, mill galvanized to ASTM A641/A641M, Class 3; 0.1483 inch (3.8 mm) side rods with 0.1483 inch (3.8 mm) cross rods; width as required to provide not more than 1 inch (25 mm) and not less than 1/2 inch (13 mm) of mortar coverage on each exposure.
 - a. Application: Masonry walls without vertical reinforcement.
 - b. Product: H-B; #120 Truss Mesh Reinforcement.
 - 1) Provide pre-fabricates corners and tees.
- D. Strap Anchors: Bent steel shapes configured as required for specific situations, 1-1/4 in (32 mm) width, 0.105 in (2.7 mm) thick, lengths as required to provide not more than 1 inch (25 mm) and not less than 1/2 inch (13 mm) of mortar coverage from masonry face, corrugated for embedment in masonry joint, hot dip galvanized to ASTM A 153/A 153M, Class B.
 1. Product: H-B; #344 Rigid Partition Anchor.

2.06 FLASHINGS

- A. Manufacturer:
 1. Specified Manufacturer: Hyload, Inc..
 - a. Contacts: P: 800-457-4056 / Web: www.hyload.com / Email: info@hyload.com
 - b. Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be acceptable.
 2. Specified Manufacturer: Hyload, Inc..
 - a. Other Acceptable Manufacturer: None identified. No substitutions will be considered or accepted.
 - b. Contacts: P: 800-457-4056 / Web: www.hyload.com / Email: info@hyload.com
- B. Membrane Flexible Flashing:
 1. Product: Hyload; HyTuf, cloaked flashing system.
 2. Self adhered Flashing Membrane With Out Drip Edge: Standard type, elastomeric and thermal plastic polymers combined with Dupont Elvaloy, reinforced with synthetic fibers and calendered into 40 mil thick sheets. A disposable silicone release sheet is adhered to the bottom adhesive side.
 - a. Width: Provide the widths required for the detail indicated on the Drawings.
 - b. Color: Gray.
 - c. Properties:
 - 1) Elongation: ASTM D412; 175 percent, minimum.
 - 2) Tensile Strength: ASTM D412; 650 psi, minimum.
 - 3) Tear Strength: ASTM D624; 280 psi.
 - 4) Low Temperature Flexibility: ASTM D 146; minus 25 degrees F Pass.
 - 5) Compatible with Urethane and Silicone sealant
 - 6) UV Stable

01-17-2022

3. Preformed Shapes: Hyload HyTUF Preformed Shapes are manufactured of high performance black polymeric membrane by vacuum forming or injection molding. Cloaks are one-piece construction with no seams and are provided in several shapes. Provide shapes as needed to meet Project requirements including, but not limited to the following:
 - a. Outside Corners.
 - b. Stop Ends.
 - c. Corner Caps.
 - d. Other special applications.
4. Accessories
 - a. Primer: Hyload Hyprime Primer.
 - b. Mastic: Hyload Mastic, neoprene-based mastic used to seal top edges of membranes, membrane to membrane and membrane to Cloak laps and penetrations.
 - c. Sealant: Hyload Structural Sealant.
 - d. Membrane Adhesive: Hyload Membrane Adhesive.
 - e. Termination Bar: HyTUF Flexible Termination Bar: A Polymeric, reinforced membrane extrusion, incorporating Dupont's Elvaloy® KEE polymer extruded into a 1/4" x 1" with chamfered edges to accept sealant or mastic. Available in 25' and 50' lengths
 - f. Drip Edge: HyTUF Flexible Drip Edge: A Polymeric, reinforced membrane extruded into a 75-mil thick by 3 1/2-inch shape, with one 1/2-inch length edge that terminates at a 45-degree angle.

2.07 MISCELLANEOUS MASONRY ACCESSORIES

- A. Manufacturers:
 1. Specified Manufacturer: Hohmann & Barnard, Inc (H-B)
 - a. Contact: P: 800-645-0616 / Web: www.h-b.com
 2. Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be acceptable.
 - a. Blok-Lok Limited .
 - b. AA Wire Products.
 - c. Wire-Bond.
 - d. National Wire Products Corp.
- B. Compressible Filler (Soft Joints): 3/8-inch thick closed-cell Neoprene Sponge conforming to ASTM D1056, Grade 2A-1.
 1. Widths as required.
 2. Product: H-B Model 'NS - Closed Cell Neoprene Sponge'.
 3. Substitutions: 01 25 00 - Substitution Procedures.
- C. Pre-formed Control Joint/Expansion Joint Gaskets - PVC:
 1. Closed cell polyvinyl chloride; oversized 50 percent to joint width; self expanding.
 2. PVC material per ASTM D2287-684.
 3. Durrmeter hardness of 85, per ASTM D2240/ASTM D2240.
 4. Product: H&B 'VS Series - PVC Control Joint'.
 - a. Provide size and configuration as required for block width and joint condition.
- D. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

2.08 CAVITY PROTECTION

- A. Manufacturers:
 1. Specified Manufacturer: Mortar Net Solutions.
 - a. Contact: P: 800-664-6638 / Web: www.mortarnet.com
 2. Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be acceptable.
 - a. Advanced Building Products, Inc.
 - b. CavClear/Archovations, Inc.

01-17-2022

- c. Dayton Superior Corporation.
- B. Cavity Protection: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage.
 - 1. Product: MortarNet™ with Insect Barrier™.
 - 2. Type: Polyester mesh, 90-percent open.
 - 3. Configuration: Strips, full-depth of cavity and 10-inches high, with dovetail shaped notches 7-inches deep.
- C. Weep / Cavity Vents:
 - 1. Product: Mortar Net; WeepVent™
 - 2. Type: Provide UV stable polyester mesh, rectangular shape, inserted in brick cavity wall open head joint.
 - 3. Size: 2 5/8-inches by 3 1/2-inches by 1/2-inch.
 - 4. Color: Selected from manufacturer's full line.

2.09 CAVITY WALL INSULATION

- A. Specified Manufacturer: Insert manufacturer name.
 - 1. Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be acceptable.
 - a. Diversifoam Products.
 - b. Dow Chemical.
 - c. Owens Corning.
- B. Product: FOAMULAR® 250 XPS rigid board insulation,.
 - 1. Type Classification: ASTM C578, Type IV.
 - 2. Board Thickness: As required to achieve R-value required by the 2015 IECC for continuous insulation (ci):
 - a. 2-inches thick by 16-inches wide.
 - b. Continuous Cavity Wall Insulation: R-10.
 - 3. Board Size: 48 by 96 inch (1220 by 2440 mm).
 - 4. Board Edges: Square.
- C. Physical Properties:
 - 1. Flame Spread Index (ASTM E84): 5.
 - 2. Smoke Developed Index (ASTM E84): 45-175.
 - 3. Density: 1.55 lb/cu ft.
 - 4. Compressive Strength (ASTM D1621): 25 psi (173 kPa), minimum.
 - 5. Thermal Resistance: R-value (RSI-value); 1 inch (25 mm) of material = R 5.0 (0.88) at 75 degrees F (24 degrees C) mean temperature.
 - 6. Water Absorption, Maximum (ASTM C272): 0.10-percent, by volume.
 - 7. Water Vapor Permeance (ASTM E96): 1.5 perms, maximum.
 - 8. Indoor Air Quality: Compliance certified by independent third party such as GREENGUARD Indoor Air Quality Certified® and/or GREENGUARD Children and Schools Certified.
 - 9. Recycled Content: Minimum 20%, certified by independent third party such as Scientific Certification Systems.

2.10 MASONRY CLEANERS

- A. Basis of Design Manufacturer/Products: Subject to compliance with the Contract Documents, products of the manufacturer's listed below will be acceptable.
 - 1. ProSoCo.
 - 2. Sure Klean.
 - 3. Diedrich Technologies, Inc.
- B. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use

01-17-2022

by cleaner manufacturer and manufacturer of masonry units being cleaned.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive masonry.
- B. Verify that related items provided under other sections are properly sized and located.
- C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 INSTALLATION, GENERAL

- A. Thickness: Build cavity, composite walls, and other masonry construction to full thickness shown.
 - 1. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.03 TOLERANCES

- A. Dimensions and Locations of Elements:
 - 1. Maximum Variation from Cross Sectional Thickness of Walls: 1/4-inch (6 mm).
 - 2. Maximum Variation of Elements in Plan: 1/2-inch.
 - 3. Maximum Variation of Elements in Elevation: 1/2-inch.
- B. Lines and Levels:
 - 1. Maximum Variation from Level Coursing: 1/4-inch in 10-feet (6 mm/3 m), or 1/2-inch maximum.
 - 2. Maximum Variation from Level for Conspicuous Horizontal Lines (i.e. lintels, sills, parapets, reveals, etc.): 1/4-inch in 20-feet, or 1/2-inch maximum.
 - 3. Maximum Variation from Plumb for Vertical Lines and Surfaces: 1/4-inch in 10-feet; or 1/2-inch maximum.
 - 4. Maximum Variation from Plumb for Conspicuous Vertical Lines (i.e. exterior corners, door/window jambs, control joints, reveals, etc.): 1/4-inch in 20-feet, or 1/2-inch maximum.
 - 5. Maximum Variation for Lines and Surfaces: 1/4-inch in 10-feet, or 1/2-inch maximum.
 - 6. Maximum Variation From Unit to Adjacent Unit: 1/16 inch (1.6 mm).
- C. Joints:
 - 1. Maximum Variation of Mortar Joint Thickness: Bed Joints: Plus or minus 1/8-inch, with a maximum thickness limited to 1/2-inch.
 - 2. Maximum Variation of Mortar Joint Thickness: Head Joints: 1/8-inch.

3.04 COLD AND HOT WEATHER REQUIREMENTS

- A. Cold Weather Requirements:
 - 1. All materials shall be heated to a temperature such that they will remain above 35° F, until they have been placed and protected against freezing for at least 48 hours after placing. Mortar shall have temperature maintained between 50°F and 90°F during placement.
 - 2. Unless precautions are taken for adequate protection, no masonry shall be built until temperature is 40°F, and rising, and expected to remain above 40°F, for the following 24 hours.
 - 3. At temperatures below 40°F, adequate equipment shall be provided for heating the materials, including the mixing water. Mixing water as placed in the mixer shall not exceed 120°F.
 - 4. Masonry Contractor shall wet walls during initial 48 hours of setting time when natural temperatures are below 40°F, and protective heating measures are being used.

01-17-2022

5. Cold Weather Cleaning: Use liquid cleaning methods only when air temperature is 40°F and above and will remain so until masonry has dried out, but not less than 7 days after completion of installation.
 6. Frozen masonry shall be removed and replaced at no extra cost to Owner.
- B. Hot Weather Requirements:
1. Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout.
 2. Provide artificial shade and wind breaks and use cooled materials as required.
 3. Do not apply mortar to substrates with temperatures of 100° F and above.

3.05 BOND PATTERN

- A. Establish lines, levels, and bond pattern indicated. Protect from displacement.
- B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- C. Brick Units:
1. Brick Type: Modular.
 2. Bond: Running.
 3. Coursing: Three units and three mortar joints to equal 8 inches (200 mm).
 4. Mortar Joints: Concave.

3.06 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Lay hollow masonry units with face shell bedding on head and bed joints.
- C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- D. Remove excess mortar and mortar smears as work progresses.
1. Do not use acids, sandblasting or high-pressure cleaning methods.
- E. Interlock intersections and external corners.
1. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
- H. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

3.07 COMPOSITE MASONRY

- A. Bond wythes of composite masonry together with masonry joint reinforcement.
- B. Corners: Provide interlocking masonry unit bond in each wythe and course at corners unless otherwise indicated.
1. Provide continuity with masonry-joint reinforcement at corners by using prefabricated L-shaped units as well as masonry bonding.
- C. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together.
1. Provide continuity with masonry-joint reinforcement by using prefabricated T-shaped units.

3.08 CAVITY WALLS

- A. Bond wythes of cavity walls together using adjustable-type (two-piece-type) ties to allow for differential movement between wythes.
- B. Keep cavities clean of mortar droppings and other materials during construction. Refer to "Cavity Mortar Control" article this Section.
- C. Install weeps in veneer and cavity walls at 24 inches (600 mm) on center horizontally at bottom of walls.

3.09 CAVITY MORTAR CONTROL

- A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep/cavity vents.
- B. For cavity walls, build inner wythe ahead of outer wythe to accommodate accessories.
- C. Install cavity mortar diverter at base of cavity and at other flashing locations as recommended by manufacturer to prevent mortar droppings from blocking weep/cavity vents.

3.10 MASONRY JOINT REINFORCEMENT

- A. Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches (400 mm) on-center vertically.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches (400 mm) each side of opening.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Lap joint reinforcement ends minimum 6 inches (150 mm).
- E. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- F. Provide continuity at wall intersections by using prefabricated T-shaped units.
- G. Provide continuity at corners by using prefabricated L-shaped units.
- H. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, pipe enclosures, and other special conditions.
- I. Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 36 inches (900 mm) horizontally and 24 inches (600 mm) vertically.

3.11 CONTROL AND EXPANSION JOINTS

- A. General: Install control-joint and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Forming control/expansion joints in concrete masonry (options):
 - 1. Install preformed control-joint gaskets designed to fit standard sash block.
 - 2. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
- C. Forming control joints in brick:
 - 1. Form open joint full depth of brick wythe and 3/8-inches wide, for installation of sealant and backer rod.
 - 2. Install compressible filler (soft joint) at joint, for installation of sealant.

3.12 MASONRY FLASHINGS

- A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
 - 1. Extend flashings full width at such interruptions and at least 6 inches (152 mm), minimum, into adjacent masonry or turn up at least 8 inches (203 mm), minimum, to form watertight pan at non-masonry construction.
 - 2. Remove or cover protrusions or sharp edges that could puncture flashings.

- B. Lap end joints of flashings at least 6 inches (152 mm), minimum, and seal watertight with flashing sealant/adhesive.

3.13 BUILT-IN WORK

- A. As work progresses, install built-in metal door frames and other items to be built into the work and furnished under other sections.
- B. Install built-in items plumb, level, and true to line.
- C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
 - 1. Fill adjacent masonry cores with grout minimum 12 inches (300 mm) from framed openings.

3.14 CUTTING AND FITTING

- A. Cut and fit for chases. Coordinate with other sections of work to provide correct size, shape, and location.
- B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.15 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
- B. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140/C140M for conformance to requirements of this specification.
- C. Mortar Tests: Test each type of mortar in accordance with ASTM C780, testing with same frequency as masonry samples.

3.16 REPAIRING, POINTING, AND CLEANING

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

3.17 PROTECTION

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

END OF SECTION 04 20 00

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

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 SECTION INCLUDES

- A. Structural steel.
- B. Grout.

1.03 RELATED REQUIREMENTS

- A. Section 05 21 00 - Steel Joist Framing.
- B. Section 05 31 00 - Steel Decking
- C. Section 05 40 00 - Cold-Formed Metal Framing
- D. Section 05 50 00 - Metal Fabrications

1.04 REFERENCES

- A. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges; 2016.
- B. AISC 341 - Seismic Provisions for Structural Steel Buildings; 2016.
- C. AISC 360 - Specification for Structural Steel Buildings; 2010.
- D. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2014.
- E. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
- F. ASTM A490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength; 2014a.
- G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2018.
- H. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished; 2018.
- I. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- J. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2013.
- K. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts; 2015.
- L. ASTM A563M - Standard Specification for Carbon and Alloy Steel Nuts (Metric); 2007 (Reapproved 2013).
- M. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel; 2018.
- N. ASTM A992/A992M - Standard Specification for Structural Steel Shapes; 2011 (Reapproved 2015).
- O. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2017.
- P. ASTM F1852 - Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2011.
- Q. ASTM F959/F959M - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series; 2017a.

- R. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength; 2018.
- S. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).
- T. SSPC-SP 1 - Solvent Cleaning; 2015.
- U. SSPC-SP 2 - Hand Tool Cleaning; 1982 (Ed. 2004).

1.05 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- B. Heavy Sections: Rolled and built-up sections as follows:
 - 1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches (38 mm).
 - 2. Welded built-up members with plates thicker than 2 inches (50 mm).
 - 3. Column base plates thicker than 2 inches (50 mm).

1.06 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include embedment drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
 - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
 - 5. For structural-steel connections indicated to comply with design loads, include structural design data signed and sealed by the qualified professional engineer, licensed in the state in which the project is located, responsible for their preparation.
 - a. Calculations must be submitted with the shop drawings for review.
 - b. Indicate all applicable piece marks on calculations sheets.
 - c. Design simple shear connections for maximum factored reaction indicated. If no reaction has been indicated, design simple shear connections to withstand one-half the maximum uniform load for the given beam span noted in the AISC Steel Construction Manual Table.
 - d. Design moment connections for factored reactions indicated. If no reaction is provided, design the moment connection for the maximum available moment capacity of the smaller beam member framing into the joint.
 - e. Design axial loaded members of trusses and bracing for the factored reactions indicated. If no reaction is indicated, design the member for the maximum tension and compression forces available to the member based on size and length. All bolted connection design shall account for net area reduction of the members.
- C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:
 - 1. Power source (constant current or constant voltage).
 - 2. Electrode manufacturer and trade name, for demand critical welds.
- D. Qualification Data: For qualified Installer, fabricator, professional engineer, and testing agency.
 - 1. Qualification Data must be submitted to Engineer prior to commencing work.
- E. Welding certificates.
- F. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- G. Mill test reports for structural steel, including chemical and physical properties.
- H. Product Test Reports: For the following:

1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 2. Direct-tension indicators.
 3. Tension-control, high-strength bolt-nut-washer assemblies.
 4. Shear stud connectors.
 5. Shop primers.
 6. Non-shrink grout.
- I. Source quality-control reports.

1.07 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
1. As an exception, non-AISC certified fabricators will be accepted provided the fabricator includes in their bid the services of the owner's special inspection and testing agency to provide inspection / testing services for in-shop work to meet the requirements of IBC Section 1704 and any additional requirements noted in the construction documents. Final costs of these services will be as required by the owner's special inspection and testing agency, which may or may not be hired at the time of bidding the project. It will be the fabricator's responsibility for estimating these costs. Cost will be withheld from the fabricator to pay for these services. Refer to IBC Section 1705 for verification and inspection requirements.
 2. All inspection costs incurred by the Owner's inspection and testing agency for this exception will be tracked and invoiced to the owner independently of other special inspection costs to allow withholding from the relevant contractor's regular payments.
- B. Installer Qualifications: Engage an experienced Installer who has completed structural steel work similar in material, design and extent to that indicated for this Project and with a record of continuous successful in-service performance for a minimum of 5 years. Installer shall provide
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.
- D. Comply with applicable provisions of the following specifications and documents:
1. AISC 303.
 2. AISC 341 and AISC 341s1.
 3. AISC 360.
 4. RCSC's "Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts."

1.08 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering design by a qualified professional engineer licensed in the state which the project is located, to withstand loads indicated and comply with other information and restrictions indicated.
1. Select and complete connections using schematic details indicated and AISC 360
 2. Use ASD; data are given at unfactored-load level.
 3. For beams where no factored shear reaction is indicated, design connections to sustain 40 percent of the beam shear capacity as shown in AISC 360, Table 3-6.
- B. Moment Connections: Type FR, fully restrained.
- C. Construction: As indicated.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
 1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
 2. Clean and relubricate bolts and nuts that become dry or rusty before use.
 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F1852 fasteners and for retesting fasteners after lubrication.

1.10 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.01 STRUCTURAL STEEL MATERIALS

- A. W-Shapes: ASTM A992/A992M.
- B. Channels, Angles, S-Shapes: ASTM A36/A36M.
- C. Plate and Bar: ASTM A36/A36M, unless otherwise indicated on Drawings.
- D. Plate and Bar for Plate Girders: ASTM A992/A992M (Grade 50). ASTM A572/A572M, Grade 50 is an acceptable substitute.
- E. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade C, structural tubing.
- F. Steel Pipe: ASTM A53/A53M, Type E or S, Grade B.
 1. Weight Class: Standard, unless otherwise indicated.
 2. Finish: Black except where indicated to be galvanized.
 3. Steel Castings: ASTM A216/A216M, Grade WCB with supplementary requirement S11.
 4. Steel Forgings: ASTM A 668/A 668M.
 5. Welding Electrodes: Comply with AWS requirements.

2.02 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A325 (ASTM A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade C, (ASTM A563M, Class 8S) heavy-hex carbon- steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
 1. Direct-Tension Indicators: ASTM F959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.
- B. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
 1. Finish: Plain.
- C. Shear Connectors: ASTM A108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- D. Headed Anchor Rods: ASTM F1554, Grade 55, weldable, straight.
 1. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
 2. Plate Washers: ASTM A36/A36M carbon steel.
 3. Washers: ASTM F436/F436M, Type 1, hardened carbon steel.
 4. Finish: Plain.
- E. Threaded Rods: ASTM A36/A36M.
 1. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.

2. Washers: ASTM F436/F436M, Type 1, hardened carbon steel.
 3. Finish: Plain, unless otherwise indicated.
- F. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A108, Grade 1035.
- G. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A108, Grade 1030.
- H. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A108, Grade 1018.

2.03 PRIMER

- A. Primer: Fabricator's standard lead- and chromate-free, non-asphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- B. Galvanizing Repair Paint: ASTM A780/A780M.

2.04 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, non-corrosive and non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

2.05 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
1. Camber structural-steel members where indicated.
 2. Fabricate beams with rolling camber up.
 3. Identify high-strength structural steel according to ASTM A6/A6M and maintain markings until structural steel has been erected.
 4. Mark and match-mark materials for field assembly.
 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning" and at architecturally exposed steel SSPC SP 3, "Power Tool Cleaning."
- F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
- G. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 2. Baseplate Holes: Cut, drill, or punch holes perpendicular to steel surfaces.
 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.06 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened, unless otherwise indicated.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.07 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
 1. Surfaces to be field welded.
 2. Surfaces to be high-strength bolted with slip-critical connections.
 3. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 4. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 1. SSPC-SP 3, "Power Tool Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 1. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
- D. Painting: Apply a 1-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

2.08 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A123/A123M.
 1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
 2. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls. Galvanize all structural steel not located in conditioned space in the final construction.

2.09 SOURCE QUALITY CONTROL

- A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
 1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
- C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welded Connections: In addition to visual inspection, all complete penetrations and shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 1. Liquid Penetrant Inspection: ASTM E 165.
 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 3. Ultrasonic Inspection: ASTM E 164.
 4. Radiographic Inspection: ASTM E 94.
- E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:
 1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.

2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
 1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

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

3.03 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 2. Weld plate washers to top of baseplate.
 3. Snug tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 1. Level and plumb individual members of structure.
 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.04 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug-tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
 2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
 3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.05 FIELD QUALITY CONTROL

- A. The Owner will employ the services of a Special Inspection Agency to perform inspections of the structural steel framing in accordance with the 2015 International Building Code (IBC)
 1. Refer to Section 01 45 33 - Code-Required Special Inspections.

3.06 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC- PA 1 for touching up shop-painted surfaces.
 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- C. Touchup Painting: Cleaning and touchup painting are specified in Division 09 painting Sections.

END OF SECTION

SECTION 05 31 00
STEEL DECKING

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 SECTION INCLUDES

- A. Steel roof deck.
- B. Composite steel floor deck.

1.03 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-In-Place Concrete
- B. Section 05 12 00 - Structural Steel Framing

1.04 REFERENCES

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2018.
- B. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2016.
- C. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2009 (Reapproved 2015).
- D. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2014a.
- E. AWS D1.3/D1.3M - Structural Welding Code - Sheet Steel; 2008.

1.05 SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
- C. Product Certificates: For each type of steel deck, signed by product manufacturer.
- D. Welding certificates.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
 - 1. Power-actuated mechanical fasteners.
 - 2. Acoustical roof deck
- F. Research/Evaluation Reports: For steel deck.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed steel deck similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM E329 for testing indicated.
- C. Welding: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- D. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those steel deck units tested for fire resistance per ASTM E 119 by a testing and inspection agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
 2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.
- E. AISI Specifications: Calculate structural characteristics of steel deck according to AISI's "Specification for the Design of Cold-Formed Steel Structural Members."
- F. FM Listing: Provide steel roof deck evaluated by FM and listed in FM's "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. BHP Steel Building Products USA Inc.
 2. Canam United States; Canam Group, Inc.
 3. Consolidated Systems, Inc.
 4. Epic Metals Corp.
 5. Marlyn Steel Products, Inc.
 6. Nucor Corp.; Vulcraft Div.
 7. Roof Deck, Inc.
 8. United Steel Deck, Inc.
 9. Vercor Manufacturing Co.
- B. Substitutions: Equivalent products complying with specified requirements will be considered, provided a manufacturer submit a request for consideration to the Architect prior to date established for receiving bids.

2.02 STEEL ROOF DECK

- A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 29, and the following:
1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 zinc coating.
 2. Deck Profile: Type WR, wide rib.
 3. Profile Depth: 1-1/2 inches and others as indicated
 4. Design Uncoated-Steel Thickness: 22 ga. as indicated on plans.
- B. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 29, and the following:
1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 zinc coating.
 2. Deck Profile: Type N.
 3. Profile Depth: 3 inches and others as indicated
 4. Design Uncoated-Steel Thickness: 18 ga. as indicated on plans.

2.03 COMPOSITE FLOOR DECK (@AHU Roof Slabs)

- A. Depth of deck and slab, type of deck, steel gauges and slab reinforcing are shown on the structural drawings.

- B. The deck acting compositely with the slab shall be capable of supporting both the design live load and the superimposed dead load indicated on the structural drawings.
- C. Fabrication: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:
- D. Material: Galvanized Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 40 (275), G60 (Z180) zinc coating.
- E. Profile Depth: As indicated on Structural Drawings.
- F. Design Uncoated-Steel Thickness: As indicated on Structural Drawings.
- G. Span Condition: Fabricate deck in lengths to span 3 or more support spacings.

2.04 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners:
 - 1. Corrosion-resistant, low-velocity, power-actuated or pneumatically driven, or
 - 2. Self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
- G. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
- H. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch (1.52 mm) thick, with factory-punched hole of 3/8-inch (9.5-mm) minimum diameter.
- I. Flat Sump Plate: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck. For drains, cut holes in the field.
- J. Galvanizing Repair Paint: ASTM A780/A780M.
- K. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.02 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.
- B. Install temporary shoring before placing deck panels, if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck, except at perimeter edges of deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions. Mechanical fasteners must meet the same pull out and shear values as welds. Engineering calculations must be provided for Engineer's review.

3.03 ROOF DECK INSTALLATION

- A. Fasten roof deck to all supporting steel as indicated on the structural drawings.
- B. Side-Lap and Perimeter Edge Fastening: As indicated on the structural drawings.
- C. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches (38 mm) long, and as follows:
 - 1. Weld Diameter: 5/8-inch (16 mm) nominal.
 - 2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated.
 - 3. Weld Washers: Install weld washers at each weld location.
- D. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 18 inches (450 mm), and as follows, unless otherwise noted:
 - 1. Mechanically fasten with self-drilling, No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.
- E. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:
 - 1. End Joints: Lapped 2 inches (51 mm) minimum.
- F. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck. Weld flanges to top of deck.
 - 1. Install reinforcing channels or zees in ribs to span between supports and weld.
 - 2. Space welds not more than 12-inches (305 mm) apart with at least one weld at each corner.
- G. Miscellaneous Roof Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.
 - 1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.
- H. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.04 COMPOSITE DECK INSTALLATION

- A. Fasten floor deck to all supporting steel by arc spot (puddle) welds of surface diameter and spacing indicated on the structural drawings.
- B. Side-Lap and Perimeter Edge Fastening: Mechanically fasten with self-drilling screws of size and spacing indicated on the structural drawings.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm) with end joints as follows:
 - 1. End Joints: Butted.

- D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.

3.05 FIELD QUALITY CONTROL

- A. The Owner will employ the services of a Special Inspection Agency to perform inspections of the steel joist framing in accordance with the 2015 International Building Code (IBC)
 - 1. Refer to Section 01 45 33 - Code-Required Special Inspections.

3.06 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.
- B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation and apply repair paint.
 - 1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
- C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 05 40 00
COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Formed steel stud exterior wall framing.

1.03 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry
- B. Section 06 16 00 - Glass-Mat Gypsum Sheathing
- C. Section 07 21 00 - Thermal Insulation
- D. Section 07 25 00 - Weather Barriers
- E. Section 07 27 26 - Fluid-Applied Membrane Air Barriers
- F. Section 07 92 00 - Joint Sealants
- G. Section 09 21 16 - Gypsum Board Assemblies
- H. Section 09 22 16 - Non-Structural Metal Framing

1.04 REFERENCES

- A. AISI S100-12 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2012.
- B. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2015.
- C. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2018.
- E. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2016.
- F. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2009 (Reapproved 2015).
- G. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2015.
- H. ASTM C955 - Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases; 2015.
- I. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2011a (Reapproved 2015).
- J. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2016a.
- K. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).
- L. AWS D1.3/D1.3M - Structural Welding Code - Sheet Steel; 2008.
- M. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); 2002 (Ed. 2004).

1.05 SUBMITTALS

- A. Product Data: Provide data on standard framing members; describe materials and finish, product criteria, limitations.
- B. Product Data: Provide manufacturer's data on factory-made framing connectors, showing compliance with requirements.
- C. Shop Drawings: Indicate component details, framed openings, bearing, anchorage, loading, welds, and type and location of fasteners, and accessories or items required of related work.
 - 1. Indicate stud and ceiling joist layout.
 - 2. Describe method for securing studs to tracks and for bolted framing connections.
 - 3. Delegated Design Submittal:
 - a. Submit structural calculations prepared by manufacturer for approval. Submittal shall be sealed by a professional engineer registered in the state of Missouri.
 - b. Design Criteria:
 - 1) Engineering analysis depicting stress and deflection (stiffness) requirements for each framing application.
 - 2) Selection of framing components, accessories and welded connection requirements.
 - 3) Verification of attachments to structure and adjacent framing components.

1.06 QUALITY ASSURANCE

- A. Designer Qualifications: Design framing system under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in Missouri.
- B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, and with minimum three years of documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.
- D. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," and AWS D1.3/D1.3M, "Structural Welding Code--Sheet Steel."
 - 1. Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure."
- E. Fire-Test-Response Characteristics: Where metal framing is part of a fire-resistance-rated assembly, provide framing identical to that of assemblies tested for fire resistance per ASTM E119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance Ratings: Indicated by GA File Numbers in GA-600, "Fire Resistance Design Manual," or by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
 - 2. AISI Specifications: Comply with AISI's "Specification for the Design of Cold-Formed Steel Structural Members" for calculating structural characteristics of cold-formed metal framing.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- B. Protect and store materials protected from exposure to rain, snow or other harmful weather conditions. Products to be handled per AISI S202 "Code of Standard Practice for Cold-Formed Steel Structural Framing."

1.08 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.09 MOCK-UP

- A. Provide mock-up of exterior framed wall, including components specified elsewhere, such as insulation, sheathing, window frame, door frame, exterior wall finish, and interior wall finish. Refer to Section 01 43 39 - Mockup Requirements, for additional requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Specified Manufacturer: ClarkDietrich. Other acceptable manufacturers with equivalent products to the specified manufacturer shall include:
 - 1. CEMCO
 - 2. Jaimes Industries
 - 3. Marino Ware
 - 4. R-stud, LLC
 - 5. SCAFCO Corporation
 - 6. Steel Construction Systems
 - 7. The Steel Network, Inc
 - 8. United Products, Inc.
- B. Products of unnamed manufacturers with equivalent products to the specified manufacturer will be considered in accordance with the "or equal" provision specified in Section 01 60 00 – Product Requirements.
 - 1. Product Substitutions: Comply with the requirements specified in Division 01 "Substitution Procedures"
- C. Framing Connectors and Accessories:
 - 1. Same manufacturer as metal framing.

2.02 FRAMING SYSTEM - DESIGN DATA

- A. Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete framing system.
- B. Design Requirements: Provide completed framing system having the following characteristics:
 - 1. Design: Calculate structural characteristics of cold-formed steel framing members according to AISI S100-16.
 - 2. Structural Performance: Design, engineer, fabricate, and erect to withstand specified design loads for project conditions within required limits.
 - 3. Design Loads: Includes live and dead loads on floor and roofs, snow loads, and wind loads:
 - a. As indicated on the structural drawings, .
 - 4. Live load deflection meeting the following, unless otherwise indicated:
 - a. Floors: Maximum vertical deflection under live load of 1/480 of span.
 - b. Roofs: Maximum vertical deflection under live load of 1/240 of span.
 - c. Exterior Walls: Maximum horizontal deflection under wind load of 1/360 of span.
 - d. Design non-axial loadbearing framing to accommodate not less than 1/2 in vertical deflection.
 - 5. Able to tolerate movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
 - 6. Able to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.
- C. Shop fabricate framing system to the greatest extent possible.
- D. Deliver to site in largest practical sections.

2.03 FRAMING MATERIALS

- A. Studs and Track: ASTM C955; studs formed to channel, "C", or "Sigma" shape with punched web; U-shaped track in matching nominal width and compatible height.

1. Gage and Depth: As required to meet specified performance levels.
 2. Galvanized in accordance with ASTM A653/A653M, G90/Z275 coating.
 3. Provide components fabricated from ASTM A1008/A1008M, Designation SS (structural steel).
- B. Joists and Purlins: Fabricated from ASTM A653/A653M steel sheet, with G90/Z275 hot dipped galvanized coating.
1. Base Metal: As required to meet specified performance levels within maximum depths indicated.
 2. Gage and Depth: As required to meet specified performance levels.
- C. Framing Connectors: Factory-made, formed steel sheet.
1. Material: ASTM A653/A653M SS Grade 33 and 40 (minimum), with G90/Z275 hot dipped galvanized coating for base metal thickness less than 10 gage, 0.1345 inch, and factory punched holes and slots.
 2. Structural Performance: Maintain load and movement capacity required by applicable code, when evaluated in accordance with AISI S100-16.
 3. Movement Connections: Provide mechanical anchorage devices that accommodate movement using slotted holes, shouldered screws or screws and anti-friction or stepped bushings, while maintaining structural performance of framing. Provide movement connections where indicated on drawings.
 - a. Where top of stud wall terminates below structural floor or roof, connect studs to structure in manner allowing vertical and horizontal movement of slab without affecting studs; allow for minimum movement of 3/4 inch.
 - b. Provide top track preassembled with connection devices spaced to fit stud spacing indicated on drawings; minimum track length of 10 feet.
 - c. Products:
 - 1) ClarkDietrich; Drift FastClip Slide Clip D-FCSC: www.clarkdietrich.com/#sle.
 - 2) ClarkDietrich; FastClip Slide Clip FCSC: www.clarkdietrich.com/#sle.
 4. Fixed Connections: Provide non-movement connections for tie-down to foundation, floor-to-floor tie-down, roof-to-wall tie-down, joist hangers, gusset plates, and stiffeners.
 - a. Products:
 - 1) Simpson Strong Tie: www.strongtie.com/#sle.
 5. Wall Stud Bridging Connections: Provide mechanical load-transferring devices that accommodate wind load torsion and weak axis buckling induced by axial compression loads. Provide bridging connections where indicated on the drawings.
 6. Products:
 - a. ClarkDietrich; Spazzer 5400 Bridging Bar: www.clarkdietrich.com/#sle.
 - b. ClarkDietrich; FastBridge Clip: www.clarkdietrich.com/#sle.
 - c. Simpson Strong Tie: www.strongtie.com/#sle.

2.04 MATERIALS

- A. Cold-Formed Steel Sheet: Complying with ASTM A1003/A1003M; unless indicated otherwise.
- B. Protective Coating: CP60 coating designator minimum (G60, A60, AZ50, GF30), complying with ASTM C955 and AISI S240.
1. Where required: CP90 coating designator minimum (G90, AZ50, GF45), complying with ASTM C955 and AISI S240.

2.05 FRAMING SYSTEM - COMPONENTS

- A. Structural Studs:
1. ClarkDietrich; "Cold-Formed Steel C-Studs".
 2. Gage and Web Depth: As required to meet specified performance levels.
 3. Minimum Yield Strength: As required for design.
- B. Structural Track:
1. ClarkDietrich; "Cold-Formed Steel Track".
 2. Web Depth: Match stud web size.

3. Minimum Yield Strength: As required for design.
 4. Material Thickness (Gage): Match stud/joist thickness unless design dictates heavier thickness.
- C. Slotted Deflection Track:
1. ClarkDietrich; "MaxTrak (SLT), MaxTrak 2D (SLT/H), or BlazeFrame DSL".
 2. Gage and Web Depth: As required to meet specified performance levels.
 3. Minimum Yield Strength: As required for design.
 4. Slotted or un-slotted.
- D. Deflection and Drift Clips:
1. Material Thickness: As required for design, based on application.
- E. Clip Angles (Support Clips):
1. ClarkDietrich; "EasyClip Series".
 2. Size and Material Thickness: As required for design, based on application.
- F. U-Channel:
1. ClarkDietrich; "U-Channel and FastBridge Clip".
 2. Size and Material Thickness: As required for design.
- G. Furring Channel:
1. ClarkDietrich; "Furring Channel".
 2. Size and Material Thickness: As required for design.
- H. Bridging/Spacer Bar:
1. ClarkDietrich; "TradeReady Spazzer 5400 Bridging and Spacing Bar".
 2. Material Thickness: As required for design.
- I. Web Stiffeners:
1. ClarkDietrich; "EasyClip Quick Twist Web Stiffener".
 2. Size and Material Thickness: As required for design.
- J. Load-Bearing Headers:
1. ClarkDietrich; "Heavy Duty Stud (HDS) or Header Bracket (HDSC), cold-formed galvanized one-piece load-bearing header.
 2. Size and Material Thickness: As required for design.
- K. Partial Height Wall Framing:
1. ClarkDietrich; "Pony Wall (PW)"
 2. Material Thickness: 12 gauge, 0.0966 inch (2.45mm).
 3. Size: As required for design.
- L. Framing Component Accessories: Provide the following accessories as required for a complete system.
1. Flat strapping.
 2. Angles, plates, sheets.
 3. Custom brake-formed shapes.
- M. Fasteners: Self-drilling, self-tapping screws; Steel, complying with ASTM C1513; Galvanized coating, plated or oil-phosphate coated complying with ASTM B633, as needed for required corrosion resistance.
- N. Touch-Up Paint: Complying with ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings. Zinc rich, containing 95-percent metallic zinc.

2.06 FASTENERS

- A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A153/A153M.
1. Products:

- a. ITW Commercial Construction North America; ITW CCNA-Buildex Tek's Select Series.
- b. Substitutions: Refer to Division 01 "Product Requirements".
- B. Anchorage Devices: Powder actuated.
- C. Welding: Comply with AWS D1.1/D1.1M.

2.07 WALL SHEATHING

- A. Plywood Sheathing: Refer to Section 06 15 00.
- B. Glass-Mat Gypsum Sheathing: Refer to Section 06 15 00.

2.08 ACCESSORIES

- A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.
- B. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.09 FABRICATION

- A. General: Framing components may be pre-assembled into panels prior to erecting.
- B. Fabricate panels square, with components attached in a manner so as to prevent racking or distortion.
- C. Cut all framing components squarely for attachment to perpendicular members, or as required for an angular fit against abutting members. Hold members positively in place until properly fastened.
- D. Provide insulation as specified elsewhere in all double jamb studs and double header members, which will not be accessible to the insulation Subcontractor.
- E. Axially Loaded Studs:
 - 1. Install studs to have full bearing against inside track web (1/8 inches (3.2 mm) maximum gap) prior to stud and track attachment.
 - 2. Splices in axially loaded studs are not permitted.
- F. Fasteners: Fasten components using self-tapping screws or welding.
- G. Welding: Welding is permitted on 18 gauge or heavier material only.
 - 1. Specify welding configuration and size on the Structural Calculation submittal.
 - 2. Qualify welding operators in accordance with Section 6.0 of AWS D.1.3.
 - 3. Touch up all welds with zinc-rich paint in compliance with ASTM A 780.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Prior to installation, inspect previous work of all other trades. Verify that all work is complete and accurate to the point where this installation may properly proceed in strict accordance with framing shop drawings.

3.02 ERECTION

- A. General Requirements:
 - 1. Install components in accordance with manufacturers' instructions and ASTM C1007 requirements.
 - 2. Weld in compliance with AWS D.1.3.
 - 3. Install in compliance with applicable sections of the AISI S240 "North American Standard for Cold-Formed Steel Structural Framing."
- B. Wall Systems:
 - 1. Erect framing and panels plumb, level and square in strict accordance with approved shop drawings.

2. Handle and lift prefabricated panels in a manner so as not to cause distortion in any member.
3. Anchor track securely to the supporting structure as shown on the erection drawings. Install concrete anchors only after full compressive strength has been achieved.
4. Butt all track joints. Securely anchor abutting pieces of track to a common structural element, or butt-weld or splice them together.
5. Align and plumb studs, and securely attach to the flanges or webs of both upper and lower tracks except when vertical movement is specified.
6. Install jack studs or cripples below window sills, above window and door heads, at freestanding stair rails and elsewhere to furnish support, securely attached to supporting members.
7. Attach wall stud bridging in a manner to prevent stud rotation. Space bridging rows according to manufacturer's recommendations.
8. Frame wall openings to include headers and supporting studs as shown in the drawings.
9. Provide temporary bracing until erection is completed.
10. Provide stud walls at locations indicated on plans as "shear walls" for frame stability and lateral load resistance.
11. Where indicated in the drawings, provide for structural vertical movement using a vertical slide clip or other means in accordance with manufacturer's recommendations.

3.03 FIELD QUALITY CONTROL

- A. Inspection: Periodic special inspections are required by local code authorities.
 1. Owner will hire and pay inspection agency.
 2. Submit schedule showing when the following activities will be performed and resubmit schedule when timing changes.
 3. Inspections are required during welding operations, screw attachment, bolting, anchoring and other fastening of components within the force resisting structural system, including struts, braces, and hold-downs.

3.04 PROTECTION

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

END OF SECTION

**SECTION 05 50 00
METAL FABRICATIONS**

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 SECTION INCLUDES

- A. Provide metal fabrications, miscellaneous metal, and related accessory items, galvanized and prime painted, complete, as shown and specified. The work includes, but is not limited to, the following:
 - 1. Steel framing and supports for operable partitions, overhead doors, coiling shutters, etc.
 - 2. Steel framing and supports for mechanical and electrical equipment.
 - 3. Steel railings, guardrails, handrails, brackets, and sockets.
 - 4. Steel ladders.
 - 5. Elevator hoist way door sill angles, sump grates, and frames.
 - 6. Metal floor plate or grating.
 - 7. Loose steel lintels.
 - 8. Steel Bollards.
 - 9. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
 - 10. Miscellaneous steel framing, supporting angles, plates, brackets, clips, anchors and bolts for equipment, and other work which is not specifically included in Section 05 12 00, but which is required to complete the Project.

1.03 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-In-Place Concrete
- B. Section 04 20 00 - Brick and Concrete Masonry
- C. Section 05 12 00 - Structural Steel Framing
- D. Section 05 43 00 - Slotted Channel Framing
- E. Section 05 51 00 - Metal Stairs, Handrails and Guards
- F. Section 07 72 00 - Roof Accessories

1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design ladders, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. Structural Performance of Aluminum Ladders: Aluminum ladders, including landings, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.05 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's literature including product characteristics, accessories and limitations.
- B. Selection Samples: Submit samples of colors and finishes if requested by architect.
- C. Verification Samples: Submit samples of selected materials specified to verify color and finish.
- D. Industry Certifications and Standards: Submit copy of documentation indicating compliance.

- E. Test and Evaluation Reports: Submit reports showing compliance with specified performance characteristics and physical properties.
- F. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer.
- B. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.
- C. Welding certificates.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.07 QUALITY ASSURANCE

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

1.08 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.09 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

PART 2 PRODUCTS

2.01 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without blemishes.

2.02 FERROUS METALS

- A. Steel Sections: ASTM A992, hot-dip galvanized for exterior use.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Steel Tubing: ASTM A 500, cold-formed steel tubing, Grade C.
- D. Steel Pipe: ASTM A 53/A 53M, Type S, Grade B, Schedule 40, unless otherwise indicated.
- E. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: 1-5/8 by 1-5/8 inches (41 by 41 mm).
 - 2. Material: Cold-rolled steel, ASTM A 1008/A 1008M, structural steel, Grade 33 (Grade 230); 0.0677-inch (1.7-mm) minimum thickness; coated with rust-inhibitive, baked-on, acrylic enamel.
- F. Stainless Steel: Steel: ASTM A240 for plate or sheet, A269 for tubing and A312 for pipe.
 - 1. Interior Use: Type 304, 18-8 grade, USS gauge, #4 finish.
 - 2. Exterior Use: Type 316L, 18-8 grade, USS gauge, #4 finish.

2.03 NON-FERROUS METALS

- A. Aluminum Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
- B. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
- C. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.

2.04 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless-steel fasteners for fastening stainless steel.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
- C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593 (ASTM F 738M); with hex nuts, ASTM F 594 (ASTM F 836M); and, where indicated, flat washers; Alloy Group 1 (A1).
- D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- E. Eyebolts: ASTM A 489.
- F. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).
- G. Lag Screws: ASME B18.2.1 (ASME B18.2.3.8M).
- H. Wood Screws: Flat head, ASME B18.6.1.
- I. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).
- J. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).
- K. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
- L. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- M. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
 2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.05 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- E. Non-shrink, Nonmetallic Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.06 MANUFACTURED UNITS

- A. Handrail Brackets: Provide Julius Blum & Co. Inc. No. 385, Blumcraft of Pittsburgh, or equal, cast malleable iron wall bracket.
 1. Provide metal bracket filler (spacer) between base of bracket and stud where bracket is mounted against gypsum board wall.

2. Provide [galvanized][powder coated] finish for exterior applications.
- B. Trench Drain: Heavy duty cast iron trench frame and grated cover, for 200mm wide trenches, 6mm slot width top with cast iron support angle frame, and galvanized steel-form pan. Provide Neenah Foundry "Model R4990-AX with Trench Type P", McKinley "Model TGMB-8", or equal.
- C. Tread Nosings: Nosings at concrete treads shall be Wooster Type WP2C, Balco, or equal. Color shall be contrasting to the concrete step color and shall be as selected by the Architect.

2.07 FABRICATION - GENERAL

- A. Verify dimensions on site prior to shop fabrication. Coordinate metalwork with adjoining work for details of attachment and fit. Be responsible for fabrication detailing and correct fitting of steel members to each other and to their supports.
- B. Use materials of size and thickness shown or, if not shown, of size and thickness to produce strength and durability in the finished product for the utility intended.
- C. Fabricate items with joints tightly fitted and secured. Make exposed joints butt tight, flush, and hairline.
- D. Grind exposed welds flush and smooth with adjacent finished surface. Ease exposed edges to small uniform radius.
- E. Fit and shop assemble in largest practical sections, for delivery to site and handling through building openings.
- F. Provide components required for anchorage of metal fabrications. Fabricate anchorage and related components of same material and finish as metal fabrication, except where specifically noted otherwise.

2.08 WELDING

- A. All surfaces shall be clean, free of rust, paint, and foreign matter of any kind. Burned edges to be welded shall be chipped clean and wire brushed before welding. Clamp members as required, space and alternate welds, as may be necessary to prevent warping or misalignment.
- B. Weld Metal: Weld metal shall be thoroughly fused with the base metal along surfaces and edges of the union. Penetration shall be 1/8 inch (4 mm) minimum and shall be into the root of the joint.
- C. Weld Quality: Welds shall present a uniform surface, free of imperfections, without undercutting or overlapping, and free from excessive oxides, gas pockets, and nonmetallic inclusions. Welds shall be made with the proper number of beads or passes to secure sound, thoroughly fused joints. Provide backup bars, temporary backup bars, or backup welds for full-penetration butt welds. Each deposit shall not exceed 1/2 inch (12 mm) of weld for each pass of bead. Preceding layers shall be cleaned by wire brushing or preening to remove scale and slag before placing new weld material.
- D. Faulty and Defective Welding: Welding showing cracks, slag inclusion, lack of fusion, bad undercut, or other defects ascertained by visual or other means of inspection, shall be chipped out and properly replaced.

2.09 RAILS

- A. Form rails and posts from steel pipe and shapes as shown on Drawings, with welded jointing. Fabricate right-angle and 45 degree bends of rail with 3 inches (75 mm) radius to center line of pipe without flattening the rail member noticeably.
- B. Coordinate with the work of Section 05 51 00.
- C. For fittings, elbows, wall brackets, and escutcheons provide machined steel. Provide splice connectors of steel as shown.
- D. Provide return at free ends of handrails to 1 inch (25 mm) from face of wall. Provide end cap for free ends of tube handrails and railings. Weld joints, end caps, returns, and transitions. Grind smooth and make flush.

- E. Provide extension for handrails and railings at edges of stairs and ramp to comply with the applicable building code, and ADA regulations.
- F. Provide mounting brackets and flanges, for secure anchorage of handrails and railings.
- G. Fabricate guardrails to comply with the specified loading requirements.

2.10 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 - 1. Fabricate units from slotted channel framing where indicated.
 - 2. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.11 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
- C. Galvanize exterior miscellaneous steel trim.
- D. Prime miscellaneous steel trim with zinc-rich primer.

2.12 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 80 steel pipe.
- B. Prime bollards with zinc-rich primer.

2.13 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

2.14 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.15 FINISH - STEEL

- A. Cleaning: Thoroughly clean mill scale, rust, dirt, grease, and other foreign matter from ferrous metal prior to galvanizing, powder coating or painting.
 - 1. Remove scale, rust, and other deleterious materials before applying shop coat. Clean off heavy rust and loose mill scale in accordance with SSPC SP-6, "Commercial Blast Cleaning."
- B. Shop Priming: Shop-paint metal work except members or portions of members to be embedded in concrete, surfaces and edges to be field welded, and galvanized surfaces.
 - 1. Immediately after surface preparation, brush or spray on primer in accordance with the paint manufacturer's instructions. Use painting methods which will result in full coverage of joints, corners, edges, and exposed surfaces.
 - 2. Apply one shop coat to metal items, except apply two coats to surfaces inaccessible after assembly or erection. Change color of the second coat to distinguish it from the first.
- C. Galvanizing: Provide a zinc coating for exposed exterior items (unless specified to be powder coated) and items to be embedded in concrete, complying with the following:

1. For galvanizing iron and steel hardware, ASTM A153.
2. For galvanizing rolled, pressed, and forged steel shapes, plates, bars, and strips 3mm thick and heavier, ASTM A123.

2.16 FINISH - ALUMINUM

- A. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the substrate and conditions in which the work is to be installed. Correct unsatisfactory substrate and conditions prior to start of installation.

3.02 PREPARATION

- A. Furnish setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, anchor bolts, and miscellaneous items having integral anchor, which are to be embedded in concrete construction. Coordinate delivery of such items to project site.
- B. Coordinate metalwork with adjoining work. Do cutting, shearing, drilling, punching, threading, tapping, etc., required for metal work and for attachment of adjacent work. Drill or punch holes; do not use cutting torch. Shearing and punching shall leave true lines and surfaces.
- C. Obtain Architect-Engineer's review prior to site cutting or making adjustments to structural members not indicated to be cut or adjusted.
- D. Clean and strip primed steel items to bare metal where site welding is to be done.
- E. Make provision for erection loads with temporary bracing. Keep work in alignment.

3.03 INSTALLATION

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners for securing metal work to in-place construction, including threaded fasteners for concrete inserts, through bolts, lag bolts, screws, and other connectors as required.
 1. Conceal fastenings where practical. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Form joints exposed to weather to exclude water.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of metal work. Set work accurately in location, alignment, and elevation, plumb, level, true, and free of rack, measured from established lines and levels. Provide temporary bracing anchors in formwork for items which are to be built into concrete or similar construction.
 1. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and touch up shop paint coat. Do not weld, cut, or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.
- C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.
- D. Corrosion Protection: Protect dissimilar metals from galvanic corrosion by pressure tapes, coating, or isolators as acceptable to Architect-Engineer.
- E. Grouting: Do grouting of frames, plates, sills, bolts, and similar items with nonshrink grout.
- F. Alignment: Verify alignment of items with adjacent construction. Coordinate related work.
- G. Handrails: Secure steel handrails with bracket. Unless otherwise noted, locate brackets 6 inches (150 mm) from ends of handrail, 6 feet (1.8 m) on center maximum, and space brackets equidistant at each handrail. Where bracket is fastened to stud wall, provide steel plate backing securely fastened to studs; toggle bolt secured to gypsum wallboard is not acceptable.

3.04 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

**SECTION 06 10 00
ROUGH CARPENTRY**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. This section specifies wood blocking, wood nailers, rough hardware, and wood backing.
- B. Preservative treatment of lumber and plywood materials.
 - 1. Blocking or furring in exterior walls.
- C. Fire-retardant treatment of lumber and plywood materials.

1.03 RELATED SECTIONS

- A. Section 09 21 16 - Gypsum Board Assemblies
- B. Section 09 22 16 - Non-Structural Metal Framing

1.04 REFERENCES

- A. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs 2020.
- B. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness 2018.
- C. ASTM D2898 - Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing 2010 (Reapproved 2017).
- D. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber 2016.
- E. ASTM D5664 - Standard Test Method for Evaluating the Effects of Fire-Retardant Treatments and Elevated Temperatures on Strength Properties of Fire-Retardant Treated Lumber.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- G. AWWA U1 - Use Category System: User Specification for Treated Wood 2018.
- H. PS 1 - Structural Plywood 2009 (Revised 2019).
- I. PS 20 - American Softwood Lumber Standard 2020.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures.
- B. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for lumber, panels, hardware and adhesives.
 - 2. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 3. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 - a. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.

01-17-2022

- C. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.
- D. Fire-Retardant Treatment Certification: Treating plant's certification of compliance with specified requirements.
- E. Preservative Treatment Certification: Treating plant's certification of compliance with specified standards, process employed, and preservative retention values.

1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
- B. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
- B. Exposure: Prevent wood products against moisture and dimensional changes, in accordance with instructions from treating plant.

1.08 WARRANTY

- A. Manufacturer's Warranty: Provide manufacturer's standard 50-year limited warranty for pressure-treated FRTW, lumber and plywood.
- B. Manufacturer's Warranty: Provide manufacturer's standard lifetime limited warranty for pressure treated lumber and plywood.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Fire-Retardant Treatment of Lumber and Plywood:
 - 1. Specified Manufacturer: Viance, LLC.
 - a. Contacts: P: 800-421-8661 / Web: www.treatedwood.com
 - 2. Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be accepted. Additional manufacturers will be considered in accordance with the "or equal" provision specified in Section 01 60 00 - Product Requirements.
 - a. Flameproof Companies
 - b. Fire Retardant Chemical Technology (FRCT).
 - c. Arch Wood Protection, Inc.
 - d. Hoover Treated Wood Products, Inc.
 - e. Koppers, Inc.
 - f. LP Building Products
 - 3. Substitutions: Submit a request for substitution for any manufacturer not named, as specified in Section 01 25 00 - Substitution Procedures.
- B. Preservative Treatment of Lumber and Plywood:
 - 1. Specified Manufacturer: Viance, LLC.
 - a. Contacts: P: 800-421-8661 / Web: www.treatedwood.com
 - 2. Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be accepted. Additional manufacturers will be considered in accordance with the "or equal" provision specified in Section 01 60 00 - Product Requirements.
 - a. Arch Wood Protection, Inc .
 - b. Koppers Performance Chemicals, Inc.

3. Substitutions: Submit a request for substitution for any manufacturer not named, as specified in Section 01 25 00 - Substitution Procedures.

2.02 WOOD PRODUCTS - GENERAL

- A. Regional Materials: Dimension lumber, except treated materials, shall be manufactured within 500 miles (800 km) of Project site.
- B. Lumber Grade Stamps: Each piece of lumber must bear grade mark, stamp, or other identifying marks indicating grades of material, and rules or standards under which produced.
- C. Lumber Grading Agency: Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
- D. Lumber:
 1. Comply with DOC PS 20.
 2. Species: Douglas Fir, unless otherwise indicated.
 - a. Lumber of other species or grades is acceptable provided structural and appearance characteristics are equivalent to or better than products specified.
 3. Lumber Surfacing: S4S.
 4. Maximum Moisture Content of Lumber:
 - a. 19-percent for 2-inch nominal (38-mm) thickness or less.
 - b. 25-percent for more than 2-inch nominal (38-mm) thickness.
- E. Plywood shall be Group 1 Species meeting requirements of U.S. Product Standard PS-1, of sizes and thicknesses indicated or required. Each panel shall carry the APA grade trademark.
 1. Species: Fir.
 2. Thickness: 5/8 inch, minimum.
 3. Plywood shall be Exterior Grade or manufactured with Exterior Glue, with C-C or C-D (plugged) faces.
 4. Fire-Retardant Treatment: Plywood shall be fire-retardant treated in accordance with AWPA C27 to have a flame spread rating of less than 25 when tested in accordance with ASTM E84
 5. Bear the mark of a recognized association or independent inspection agency that maintains continuing control over quality of plywood which identifies compliance by veneer grade, group number, span rating where applicable, and glue type.

2.03 WOOD NAILERS, BACKING, AND BLOCKING

- A. Provide continuous wood nailers, backing, and blocking in metal stud framed walls as required to support finishes, fixtures, specialty items, and trim, unless those items can be securely fastened to two or more studs or other method of support is explicitly indicated.
 1. Blocking shall include, but not be limited to, the following:
 - a. Around door and window openings for anchorage of frames.
 - b. Base and/or wall cabinets.
 - c. Countertop support brackets.
 - d. Shelf supports.
 - e. Handrails.
 - f. Wall paneling and trim.
 - g. Toilet accessories (grab bars, mirrors, etc.).
 - h. Hardware items (door stops, etc.).
 - i. Markerboards and tackboards.
 - j. Audio/Visual equipment.
 - k. Other equipment as indicated on the drawings.
- B. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
- C. Dimensional Lumber for Wood Nailers, Backing, and Blocking:
 1. Species: Douglas Fir.
 2. Surfacing: S4S.
 3. Grade:

- a. 4 inches and narrower: No. 1 or Construction Grade.
 - b. 6 inches and wider: No. 2 or Standard Grade.
- D. Fire-Retardant Treatment: Refer to "Fire-Retardant Pressure Treatment of Lumber and Plywood" Article this Section.
- E. Anchors and Fasteners:
 - 1. Anchor to metal decking with self-drilling, self- tapping, tempered steel screws manufactured for the purpose of securing items to metal decking.
 - 2. Secure to metal framing for gypsum board walls and partitions with self-drilling, self-tapping tempered steel drywall screws of type and size required for the installation.

2.04 PLYWOOD BACKING PANELS

- A. Type: PS 1, A-C plywood, or medium density fiberboard; 3/4 inch (19 mm) thick.
- B. Fire-Retardant Treatment (if applicable): Plywood shall be fire-retardant treated in accordance with AWPA C27 to have a flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.
- C. Applications:
 - 1. Plywood Exposed to View But Not Exposed to Weather: PS 1, A-D, or better.
- D. Anchors and Fasteners:
 - 1. Anchor to metal decking with self-drilling, self- tapping, tempered steel screws manufactured for the purpose of securing items to metal decking.
 - 2. Secure to metal framing for gypsum board walls and partitions with self-drilling, self-tapping tempered steel drywall screws of type and size required for the installation.

2.05 HARDWARE

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
- B. Fasteners and Metal Hardware: Provide corrosion resistant steel fasteners with Hot-dip zinc coating per ASTM A153/A153M, provide corrosion resistant hardware per ASTM A653 / A653M Class G-185 in compliance with building code requirements.
- C. Screws for Fastening to Metal Framing: ASTM C1002 or ASTM C954, length as recommended by screw manufacturer for material being fastened.

2.06 FIRE-RETARDANT PRESSURE TREATMENT OF LUMBER AND 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. Product: D-Blaze FRT, as manufactured by Viance, LLC.
- C. Physical Properties:
 - 1. Surface Burning Characteristics: Capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84.
- D. Treatment shall not promote corrosion of metal fasteners.
- E. Lumber: Comply with AWPA U1, Category UCFA, Type A, or ICC-ES ESR 2645.
- F. Plywood: Comply with AWPA U1, Use Category UCFA, Type A, or ICC-ES ESR 2645.
- G. All interior rough carpentry items are to be fire-retardant treated.
- H. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
- I. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- J. Treated wood members that must be cut in the field shall be dipped, after cutting, in the same fire-retardant chemical that was used in the pressure treating process.

2.07 PRESERVATIVE-TYPE PRESSURE TREATMENT OF LUMBER AND PLYWOOD

- A. Product: ACQ, as manufactured by Viance, LLC.
- B. Exposed lumber and plywood to receive preservative-type pressure treatment shall be pressure treated using Ammoniacal Copper Quaternary compound (ACQ).
 - 1. Preservative shall penetrate a minimum of 3/8-inch (9.5 mm) deep into wood.
- C. Preservative Treatment for Above Ground Use: AWPA U1, Use Category UC3B, as appropriate.
- D. Preservative Treatment for Ground and Fresh Water Contact: AWPA U1, Use Category UC4A, as appropriate.
- E. Preservative Treatment for Contact with Soil: AWPA U1, Category UC4A, as appropriate.
- F. Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

PART 3 EXECUTION

3.01 PREPARATION

3.02 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.

3.03 INSTALLATION - TREATED WOOD MATERIALS

- A. Fire-Retardant Treated Wood:
 - 1. Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions and product carton instructions for installation.
 - 2. End cuts and drilling are permitted. Do not rip or mill lumber after fire-retardant treatment.
- B. Preservative Treated Wood:
 - 1. Surface treatment of field cuts: All field cuts on members that provide structural support to a permanent structure shall be field treated in accordance with AWPA M4.

3.04 INSTALLATION - WOOD NAILERS, BACKING, AND BLOCKING

- A. Fireblocking: In framed assemblies that have concealed spaces, provide solid wood fireblocking as required by applicable local code.
 - 1. Other material acceptable to code authorities may be used in lieu of solid wood blocking.
- B. Provide continuous wood nailers, backing, and blocking in metal stud framed walls as required to support finishes, fixtures, specialty items, and trim, unless those items can be securely fastened to two or more studs or other method of support is explicitly indicated.

3.05 INSTALLATION - PLYWOOD BACKING PANELS

- A. Plywood Backing Panels: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches (610 mm) on center on all edges and into studs in field of board.
 - 1. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
 - 2. Install adjacent boards without gaps.
 - 3. Size and Location: As indicated on drawings.

3.06 WASTE DISPOSAL

- A. Comply with applicable regulations.

END OF SECTION 06 10 00

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**SECTION 06 16 00
GLASS-MAT GYPSUM SHEATHING**

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 SECTION INCLUDES

- A. Glass mat gypsum sheathing.

1.03 RELATED SECTIONS

- A. Section 05 40 00 - Cold-Formed Metal Framing
- B. Section 06 10 00 - Rough Carpentry
- C. Section 07 27 26 - Fluid-Applied Vapor-Permeable Membrane Air Barriers
- D. Section 09 22 16 - Non-Structural Metal Framing

1.04 REFERENCES

- A. ASTM D 5516 - Standard Test Method for Evaluating the Flexural Properties of Fire-Retardant Treated Softwood Plywood Exposed to Elevated Temperatures.
- B. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 WARRANTY

- A. The manufacturer shall warrant the product against delamination and deterioration for exposure to normal weather conditions for a period of one (1) year from Date of Substantial Completion.
- B. The manufacturer shall warrant the product against defects in manufacturing, for a period five (5) years from Date of Substantial Completion.
- C. The manufacturer shall warrant the product against defects in manufacturing when sheathing used as substrate for EIFS, for a period of twelve (12) years from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Specified Manufacturer: Georgia-Pacific (G-P) Gypsum .
 - 1. Contacts: P: 800-225-6119 / Web: www.buildgp.com
- B. Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be acceptable.
 - 1. CertainTeed Corporation; GlasRoc.
 - 2. National Gypsum Company; Gold Bond e(2)XP.
 - 3. Temple-Inland Inc.; GreenGlass
 - 4. United States Gypsum Co.; Securock.

2.02 GLASS MAT GYPSUM WALL SHEATHING

- A. Product: DensGlass® Sheathing
 - 1. Glass-Mat Gypsum Wall Sheathing: ASTM C1177/C1177M, Type X.
 - 2. Thickness: 1/2-inch.

01-17-2022

3. Installation: Screw to cold-formed metal framing.
4. Width (nom.): 48-inches.
5. Length: 8-, 9-, or 10-feet.
6. Weight: 1.9 lbs/sf.
7. R-Value: 0.56.
8. Physical Properties:
 - a. Compressive Strength: 500 psi (3445 kPa), minimum.
 - b. Permeance: > 23 perms.
 - c. Combustability: Product is noncombustible as described and tested in accordance with ASTM E136.
 - d. Surface Burning Characteristics: Flame spread rating: 0; smoke develop rating: 0, when tested in accordance with ASTM E84.
 - e. Air Barrier Compliance: Per the International Energy Conservation Code® (IECC), gypsum sheathing shall comply with the prescriptive code language for use as a continuous air barrier when the joints and openings are properly sealed.

2.03 FASTENERS

- A. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached, according to ASTM B117
 1. For steel framing less than 0.0329 inch (0.835 mm) thick, use screws that comply with ASTM C1002.
 2. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, use screws that comply with ASTM C954.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
 1. Fasten gypsum sheathing to cold-formed metal framing with screws.
 2. Install boards with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
 3. Install boards with a 1/4-inch (6.4-mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Coordinate sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- D. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- E. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.
- F. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
- G. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent boards without forcing. Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach boards at perimeter and within field of board to each steel stud.
 1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of boards.
 2. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

- H. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of boards.
- I. Seal sheathing joints according to sheathing manufacturer's written instructions.

3.02 PROTECTION

- A. Protect glass mat-surfaced gypsum sheathing that will be exposed to weather for more than 180 days by covering exposed exterior surface of sheathing with a securely fastened air-infiltration barrier. Apply covering immediately after sheathing is installed. Maximum exposure of assembly is 270 days prior to covering with exterior wall covering.
- B. Protect cutouts, corners, and joints in sheathing by filling with a flexible sealant or by applying tape recommended by sheathing manufacturer at time sheathing is applied.

END OF SECTION 06 16 00

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**SECTION 06 61 16
SOLID SURFACE FABRICATION**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Solid surface countertops.
- B. Integral sink bowls.

1.03 RELATED SECTIONS

- A. Section 06 10 00 - Rough Carpentry
- B. Section 09 21 16 - Gypsum Board Assemblies
- C. Section 12 32 16 - Manufactured Plastic Laminate Faced Casework

1.04 REFERENCES

- A. ASTM C384 - Standard Test Method for Impedance and Absorption of Acoustical Materials by Impedance Tube Method 04.
- B. ASTM E228 - Standard Test Method for Linear Thermal Expansion of Solid Materials With a Push-Rod Dilatometer 17.
- C. ASTM E84

1.05 SUBMITTALS

- A. Product data: Indicate product description, fabrication information and compliance with specified performance requirements.
- B. Shop Drawings: Indicate dimensions component sizes, fabrication details, attachment provisions and coordination requirements with adjacent work.
- C. Samples:
 - 1. Submit product data indicating compliance with specification requirements.
 - 2. Samples: Submit 2-inch by 2-inch samples
- D. Maintenance data: Submit manufacturer's care and maintenance data, including repair and cleaning instructions. Include in project close out documents.

1.06 QUALITY ASSURANCE

- A. Accessible Design: Comply with [the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."]

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver no components to project site until areas are ready for installation. Store indoors.
- B. Handle materials to prevent damage to finished surfaces. Provide protective coverings to prevent physical damage or staining following installation for duration of project.

1.08 WARRANTY

- A. The manufacturer shall warrant the product/s to be free of defects in material and workmanship for a period of ten (10) years from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Specified Manufacturer: Refer to Interior Finish Legend, Sheet A4.2.
 - 1. Other Acceptable Manufacturer: None identified. No substitutions will be considered or accepted.

2.02 SOLID SURFACING FABRICATIONS

- A. Solid Surfacing Fabrications, scheduled on the Drawings as Finish Type SSF- #.
 - 1. Refer to the "Interior Finish Legend" (Sheet A4.2) for the pertinent information on this Finish Type.
- B. Physical Properties:
 - 1. Flammability: Class A, when tested to ASTM E84
 - a. Flame Spread Index: Less than 25.
 - b. Smoke Development Index: Less than 450.
 - 2. Food Equipment Material Compliance: Food Zone to NSF 51
 - 3. Tensile Strength: 6000 psi minimum, per ASTM D638
 - 4. Tensile Modulus: 1.35×10^6 psi minimum, per ASTM D638.SOLID
 - 5. Tensile Elongation: 0.5% minimum, per ASTM D638.
 - 6. Flexural Strength: 10000 psi minimum, per ASTM D790
 - 7. Flexural Modulus: 1.34×10^6 psi minimum, per ASTM D790.
 - 8. Hardness: >85-Rockwell "M" scale minimum, per ASTM D785
 - 9. Thermal Expansion: 1.8×10^{-5} in./in./°F, per ASTM E228
 - 10. Fungi and Bacteria: Does not support microbial growth, per ASTM G21
 - 11. Microbial Resistance: Highly resistant to mold growth, per UL 2824
 - 12. Ball Impact: No fracture - 1/2 lb. Ball: NEMA LD 3
- C. Design Load: Deflection limited to 1/360.
- D. Design items with sufficient strength for handling stresses.

2.03 MATERIALS

- A. Solid Surfacing Material:
 - 1. Composition: Homogeneous-filled plastic resin complying with ISSFA-2.
 - a. Material Thickness: 1/2-inch.
 - b. Panel Weight: Per manufacturer.
 - c. Colors and Pattern: As scheduled.
 - d. Finish: As scheduled.
- B. Integral Sinks: Refer to "Solid Surface Sinks" Article this Section.
- C. Adhesives and Sealant: Refer to "Installation Accessories" Article this Section.

2.04 COUNTERTOPS

- A. Countertops shall be built-up with 1/2-inch thick solid surface sheet over a 1-inch thick sub-top, for a total thickness of 1-1/2 inches.
 - 1. Sub-Top Material: MDF and/or MR-MDF.
- B. Construction:
 - 1. Depth: As indicated on the Drawings.Countertops requiring compliance with ADA shall have a maximum depth of 24-inches (600-mm) from the farthest most projection of cabinetry to the face of back wall.
 - a. ADA Compliant Countertops shall have a maximum depth of 24-inches (600-mm), measured from the farthest most projection of cabinetry to the face of back wall.
 - 2. Edge Thickness: 1-1/2 inches.
 - 3. Edge Profile: Eased edge.
 - 4. Overhang: 1-inch (25-mm) beyond face of base cabinets.
 - 5. Open End Radii: Countertops with open ends shall have a 1 1/2-inch radius at the open end between the front and end faces.
 - 6. Transaction Tops: Same as countertops.
- C. Splashes (Back- and End-)
 - 1. Height: 4-inches high, typical.
 - 2. Thickness: 1/2-inch (12-mm).
 - 3. Splash Type/s:

01-17-2022

- a. Shop-formed integral splashes with coved assembly between horizontal and vertical surfaces.
 - 1) Coved strip assembly shall be recessed into the deck 3-mm to eliminate 'feather' at glue line.
 - 2) Provide a formed scribe strip at top of splash to permit scribing to wall surface.
 - 3) L-Shaped Returns: Shop-fabricated inside corner cove.
- b. Field-Applied Backsplashes: Provide loose fabrications to be field set, unless noted otherwise.
 - 1) Backsplashes and returns are attached to countertop with silicone adhesive.

D. Material and Color: Refer to the Interior Finish Legend (Sheet A4.2).

2.05 INSTALLATION MATERIALS

- A. Mounting Adhesive: Provide structural-grade silicone or epoxy adhesives as recommended by manufacturer for application and per conditions of use.
 - 1. Provide spacers, if required, of type recommended by adhesive manufacturer.
- B. Joint Adhesive: Methacrylate-based adhesive for chemically bonding solid surfacing seams. Color complementary to solid surfacing sheet material. UL 2818 GREENGUARD Gold certified and complying with SCAQMD Rule 1168.
 - 1. Adhesives shall have a VOC content of 70 g/L or less.
- C. Elastomeric Joint Sealant (Silicone): Mildew-resistant silicone sealant for filling gaps between countertops and terminating substrates in wet environment applications. Complies with ASTM C920, Type S (single component), Grade NS (nonsag).
 - 1. Color: Complementary to solid surfacing color.
- D. Siliconized Acrylic Joint Sealant: Siliconized acrylic latex sealant. For general applications to fill gaps between countertops and at terminating substrates. Complies with ASTM C384, Type OP, Grade NF, and SCAQMD Rule 1168.
 - 1. Color: Complementary to quartz surfacing color.
- E. Construction Adhesive: Countertop manufacturer's recommended silicone-based construction adhesive for backsplashes, endsplashes, and other applications according to manufacturer's published fabrication instructions.
- F. Solvent: Product recommended by adhesive manufacturer to clean surface of solid surfacing to assure adhesion of adhesives and sealants.
- G. Cleaning Agents: Non-abrasive, low pH cleansers.

2.06 FABRICATION

- A. Assemble work at shop following manufacturer's printed fabrication instructions and deliver to job ready for installation. Manufacture in largest practical pieces for handling and shipping without seams.
 - 1. Grade: AWI, Premium.
 - 2. Fabricate tops with shop-applied edges, backsplashes, and endsplashes unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 3. Joints: Form joints between components using manufacturer's standard joint adhesive; without conspicuous joints.
 - 4. Cut and finish component edges with clean sharp returns. Route radius and contours to template. Repair or reject defective and inaccurate work.
 - 5. Do not exceed manufacturer's recommended unsupported overhang distances.
 - 6. Integral Sinks: Refer to "Solid Surface Sinks" Article this Section.
 - 7. Provide cut-outs for plumbing fixtures and trim, washroom accessories, appliances, and related items. Confirm layout with manufacturer's cut-out templates before beginning work. Round corners of cut-outs and sand edges smooth.
 - 8. Recess and conceal fasteners, connections, and reinforcing.
 - 9. Radius corners and edges.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine walls and other surrounding construction prior to installation of solid surface fabrications.
 - 1. Verify that construction complies with indicated requirements of construction documents regarding size, configuration and other requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install components plumb and level, scribed to adjacent finishes, in accordance with approved shop drawings and product installation details.
- B. Fabricate field joints using manufacturer's recommended adhesive, with joints being inconspicuous in finished work. Exposed joints/seams are not permitted. Keep components and hands clean when making joints. Reinforce field joints as specified herein. Cut and finish component edges with clean, sharp returns.
- C. Install countertops with no more than 1/8" sag, bow or other variation from a straight line.
- D. Seal between wall and components with joint sealant.

3.03 REPAIRS

- A. Repair minor imperfections and cracked seams and replace areas of severely damaged surfaces in accordance with manufacturer's "Technical Bulletins".

3.04 SITE QUALITY CONTROL

- A. Non-Conforming Work: Replace damaged work which cannot be satisfactorily repaired, restored or cleaned, to satisfaction of Architect at no cost to Owner.

3.05 CLEANING

- A. Remove excess adhesive and sealant from visible surfaces.
- B. Clean surfaces in accordance with manufacturer's "Care and Maintenance Instructions".

3.06 PROTECTION

- A. DO NOT stand on the installed countertops for any reason.
- B. Provide protective coverings to prevent physical damage or staining following installation for duration of Project.
- C. Protect surfaces from damage until Date of Substantial Completion.

END OF SECTION 06 61 16

SECTION 06 82 00
RIGID SHEET WALL PROTECTION PANELS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Non-PVC rigid sheet for wall protection and decoration.

1.03 RELATED SECTIONS

- A. Section 07 92 00 - Joint Sealants
- B. Section 09 21 16 - Gypsum Board Assemblies

1.04 PERFORMANCE REQUIREMENTS:

- A. Rigid Vinyl:
 - 1. Fire Rating: NFPA, Class A.
 - 2. Surface Burning Characteristics per UL-723 (ASTM E84):
 - a. Flame Spread: 20 (max.)
 - b. Smoke Developed: 350 (max.)
 - 3. Self-Extinguishing Classification (ASTM D635) : CC1.
 - 4. Impact Strength (ASTM D256): 30.4 ft-lbs/ inch of thickness.
 - 5. Chemical and Stain Resistance: Provide material that shows resistance to stain when tested in accordance with applicable provisions of ASTM D543.
 - 6. Fungal and Bacterial Resistance: Provide material that does not support fungal or bacterial growth as tested in accordance with ASTM G-21 and ASTM G-22.
 - 7. GREENGUARD Certified: Provide GREENGUARD Certified sheet. Sheet shall meet the requirements of GREENGUARD Certification Standards for Low-Emitting Products and GREENGUARD Product Emission Standard for Children & Schools.

1.05 SUBMITTALS

- A. See Section 01 33 00 for submittal procedures.
- B. Product Data: Submit manufacturer's literature including product characteristics, accessories and limitations.
- C. Selection Samples: Submit samples of colors and finishes if requested by architect.
- D. Verification Samples: Submit samples of selected materials specified to verify color and finish.
- E. Industry Certifications and Standards: Submit copy of documentation indicating compliance.
- F. Test and Evaluation Reports: Submit reports showing compliance with specified performance characteristics and physical properties.
- G. Maintenance Data: Include instructions for stain removal, surface and gloss restoration.

1.06 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Manufacturer regularly engaged, for a minimum of 5-years, in the manufacturing of rigid wall protection panels of similar type to that specified.
- B. Installer's Qualifications:
 - 1. Installer regularly engaged, for a minimum of 5-years, in installation of rigid wall protection panels of similar type to that specified.
 - 2. Employ persons trained for installation of panels.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Delivery Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

01-17-2022

1.08 FIELD CONDITIONS

- A. Do not install site fabricated components when site conditions may be detrimental to successful installation.
- B. Maintain temperature and humidity conditions favorable to proper curing of resin during and after installation.

1.09 WARRANTY

- A. Manufacturer's Warranty: Provide manufacturer's standard warranty against defects in manufacturing for one (1) year from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 BASIS OF DESIGN

- A. Basis-of-Design Manufacturer / Products: Subject to compliance with the Contract Documents, provide product/s from the manufacturer's specified; No exceptions.
 - 1. Substitutions will not be considered for the materials and products specified in this Section.
- B. Basis-of-Design Manufacturer: Products from InPro Corporation are specified to establish a standard of quality for design, function, materials, and appearance.
- C. Single Source: Provide FRP panels and accessories from single manufacturer.

2.02 RIGID SHEET WALL PROTECTION PANELS

- A. Wall Protection Panels, scheduled on the Drawings as Finish Type 'WP- #'.
 - 1. Refer to the "Interior Finish Legend" (Sheet A4.2) for pertinent information on this Finish Type.
- B. Type WP-1:
 - 1. Basis of Design:
 - a. Manufacturer: Inpro Corporation.
 - b. Product: Palladium® Rigid Vinyl Sheet Wall Protection.
 - c. Substitutions: Not permitted.
 - 2. Product Specification:
 - a. Material: Rigid Vinyl Sheet: Manufactured from chemical and stain resistant polyvinyl chloride with the addition of impact modifiers. No plasticizers shall be added.
 - b. Thickness: 0.040 inches.
 - c. Panel Width: 36-inches or 48-inches.
 - d. Panel Length: 96-inches.
 - e. Surface Texture: Velvet Texture.
 - f. Color: As scheduled.
 - g. Fire Rating: Class A.
 - h. Adhesive: As recommended by manufacturer.

2.03 MATERIALS

- A. Rigid Vinyl Sheet: Shall be manufactured from chemical and stain resistant polyvinyl chloride with the addition of impact modifiers. No plasticizers shall be added.

2.04 ACCESSORIES

- A. Trim Accessory Pieces:
 - 1. Vinyl Trim: Color matched dividers, outside corners, inside corners, or top caps as required.
- B. Caulk: Color Matched Caulk

PART 3 EXECUTION

3.01 EXAMINATION

- A. Complete all finishing operations, including painting, before beginning installation of wall protection panels.

- B. Wall surfaces shall be dry and free from dirt, grease and loose paint.

3.02 INSTALLATION

- A. Install fabrications in accordance with shop drawings and manufacturer's instructions.
- B. Install panels with bottom edge located to clear top of wall base.
- C. Apply adhesive uniformly using adhesive manufacturers recommended trowel to the entire back of panels completely to the edge (100% coverage).
- D. Lay FRP panels in place leaving approximately 1/8 inch between panels and 1/4 inch space top and bottom.
- E. Follow adhesive manufacturer's recommendations for set and application times.
- F. Apply pressure to entire panel face with laminate type roller, removing trapped air and ensure proper adhesion between surfaces.

3.03 CLEANING

- A. Clean fabrications in accordance with manufacturer's instructions.

3.04 PROTECTION

- A. Place protective structural covering over installed units until the completion of the Project.

END OF SECTION 06 82 00

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SECTION 07 14 00
FLUID-APPLIED WATERPROOFING

PART 2 PRODUCTS

1.01 FLUID APPLIED WATERPROOFING MATERIALS

END OF SECTION 07 14 00

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**SECTION 07 21 00
THERMAL INSULATION**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Rigid foam board insulation, EPS and XPS.
- B. Acoustical blanket insulation.
- C. Fiberglass batt insulation.
- D. Mineral wool insulation.
- E. Perimeter containment systems.
- F. Fire safing insulation.

1.03 RELATED SECTIONS

- A. Section 06 10 00 - Rough Carpentry
- B. Section 06 16 00 - Glass Mat Gypsum Sheathing
- C. Section 06 16 10 - Sheathing with Integral Water and Air Barrier
- D. Section 06 16 63 - Composite Insulating Wall Sheathing
- E. Section 07 27 26 - Fluid-Applied Vapor-Permeable Membrane Air Barriers
- F. Section 09 21 16 - Gypsum Board Assemblies

1.04 REFERENCES

- A. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings 2019.
- B. ASTM C303 - Standard Test Method for Dimensions and Density of Preformed Block and Board—Type Thermal Insulation.
- C. ASTM C303 - Standard Test Method for Dimensions and Density of Preformed Block and Board—Type Thermal Insulation 10.
- D. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method 2017.
- E. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- F. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).
- G. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation 2019.
- H. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).
- I. ASTM C1104 - Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
- J. ASTM D1621 - Standard Test Method for Compressive Properties Of Rigid Cellular Plastics 2016.
- K. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus 2020.
- L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- M. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials 2016.

01-17-2022

1.05 SUBMITTALS

- A. See Section 01 33 00 for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials and accessories in insulation manufacturer's original packaging with identification labels intact and in sizes to suit project.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Ensure insulation materials are not exposed to moisture during delivery or storage.

1.07 SEQUENCING

- A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.08 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Specified Manufacturer: Owens Corning Insulating Systems, LLC unless noted otherwise.
 - 1. Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be acceptable.
 - a. Dow Chemical Company.
 - b. DiversiFoam Products.
 - c. Certain Teed Corporation.
 - d. ACH Foam Technologies, LLC.
 - e. Knauf Insulation.
 - f. Rockwool.
 - g. InsulFoam LLC (Carlisle)
 - h. Kingspan Insulation, LLC

2.02 APPLICATIONS

- A. Below Grade Insulation:
 - 1. Under-Slab and Perimeter Foundation Insulation: Extruded polystyrene rigid board.
 - 2. Continuous Insulation over Concrete Walls: Expanded polystyrene rigid board.
- B. Metal-Framed Exterior Wall Construction:
 - 1. Stud Cavity Insulation: Fiberglass batt insulation, faced or unfaced.
 - 2. Continuous Insulation: Extruded polystyrene rigid board over wall sheathing.
- C. Metal-Framed Interior Wall Construction:
 - 1. Stud Cavity Insulation: Sound attenuation batt insulation, unfaced.
- D. Wood-Framed Exterior Wall Construction:
 - 1. Stud Cavity Insulation: Fiberglass batt insulation, faced or unfaced.
 - 2. Continuous Insulation: Extruded polystyrene rigid board over wall sheathing.
- E. Wood-Framed Interior Wall Construction:
 - 1. Stud Cavity Insulation: Sound attenuation blanket insulation, unfaced.
- F. Insulation above Acoustical Ceilings: Fiberglass batt insulation, unfaced.
- G. Roof Deck Insulation: Refer to Section INSERT SECTION # for requirements.

01-17-2022

2.03 EXPANDED POLYSTYRENE (EPS) INSULATION

- A. Manufacturer: InsulFoam LLC
 - 1. Contacts: P: 800-248-5995 / Web: www.insulfoam.com
- B. Product: Insulfoam 25 PSI Moisture-Resistant Insulation.
 - 1. Type Classification: ASTM C578, Type IX, unfaced.
 - 2. Board Thickness: As required to achieve R-value required by the 2015 IECC for continuous insulation (ci).
 - a. Insulation over Concrete Walls: R-7.5
 - b. Waterproofing Protection Barrier: R-7.5
- C. Physical Properties:
 - 1. Flame Spread Index (ASTM E84): Less than 20, Class A.
 - 2. Smoke Developed Index (ASTM E84): 150-300.
 - 3. Compressive Strength (ASTM D1621): 25 psi (173 kPa), minimum.
 - 4. Thermal Resistance (ASTM C518): R-value (RSI-value) of 4.35 (0.76) per 1 inch (25.4 mm) at 75 degrees F (24 degrees C) mean temperature.
 - 5. Density (ASTM C303): 2.0 pcf.
 - 6. Water Absorption (ASTM C272): 2-percent by volume, maximum.
 - 7. Water Vapor Permeance (ASTM E96): 2.0 perms, maximum.
 - 8. Flexural Strength, ASTM C 203: Minimum 50 psi.
 - 9. Dimensional Stability, ASTM D 2126: Maximum 2 percent.
- D. Accessories:
 - 1. Adhesive: Material and type compatible with EPS insulation board and acceptable to EPS insulation board manufacturer.
 - 2. Wall Ties: Material and type compatible with EPS insulation board and acceptable to EPS insulation board manufacturer.
 - 3. Mechanical Fasteners: Material and type compatible with EPS insulation board and acceptable to EPS insulation board manufacturer.
 - 4. Furring Channels: Material and type compatible with EPS insulation board and acceptable to EPS insulation board manufacturer.
- E. Uses: Refer to "Applications" Article this Section.

2.04 EXTRUDED POLYSTYRENE (XPS) INSULATION

- A. Manufacturer: Owens Corning Insulating Systems, LLC.
- B. Product: FOAMULAR® 250 XPS rigid board insulation.,.
 - 1. Type Classification: ASTM C578, Type IV.
 - 2. Board Thickness: As required to achieve R-value required by the 2015 IECC for continuous insulation (ci):
 - a. Underslab and perimeter foundation insulation: R-10.
 - b. Exterior walls with continuous insulation over sheathing:
 - 1) Metal-framed wall systems: R-7.5ci
 - 2) Wood-framed wall systems: R-3.8ci
 - 3. Board Size: 48 by 96 inch (1220 by 2440 mm).
 - 4. Board Edges: Square.
- C. Physical Properties:
 - 1. Flame Spread Index (ASTM E84): 5.
 - 2. Smoke Developed Index (ASTM E84): 45-175.
 - 3. Density: 1.55 lb/cu ft.
 - 4. Compressive Strength (ASTM D1621): 25 psi (173 kPa), minimum.
 - 5. Thermal Resistance: R-value (RSI-value); 1 inch (25 mm) of material = R 5.0 (0.88) at 75 degrees F (24 degrees C) mean temperature.
 - 6. Water Absorption, Maximum (ASTM C272): 0.10-percent, by volume.
 - 7. Water Vapor Permeance (ASTM E96): 1.5 perms, maximum.

01-17-2022

8. Indoor Air Quality: Compliance certified by independent third party such as GREENGUARD Indoor Air Quality Certified® and/or GREENGUARD Children and Schools Certified.
9. Recycled Content: Minimum 20%, certified by independent third party such as Scientific Certification Systems.

D. Uses: Refer to "Applications" Article this Section.

2.05 POLYISOCYANURATE INSULATION

- A. Refer to Section 07 52 01 for membrane roofing system requirements.
- B. Application: Insulation over wood roof decking.

2.06 ACOUSTIC BLANKET INSULATION (SOUND ATTENUATION BATTS)

- A. Manufacturer: Owens Corning Insulating Systems, LLC.
- B. Product: EcoTouch® Unfaced Sound Attenuation Batts (SABs).
 1. Type: Unfaced glass fiber acoustical insulation, complying with ASTM C665, Type I.
 2. Fire-Resistance: When installed in wall systems and tested per ASTM E119, assembly fire-resistance ratings up to 2-hours can be achieved.
 3. Insulation Thickness: 2-1/2 or 3-1/2 inches thick.
 4. Insulation Width: Provide 16-inch wide batts to fit stud spacing, unless noted otherwise.
 5. Insulation Length: 96-inches.
- C. Physical Properties:
 1. Surface Burning Characteristics (ASTM E84): Flame Spread Index: 10; Smoke Developed Index: 10.
 2. Combustibility (ASTM E136): Non-combustible.
 3. Mold/mildew resistant per ASTM C138/C138M.
 4. Water Vapor Sorption (ASTM C1104): Less than 0.05 by volume, maximum.
 5. Dimensional Stability: Linear Shrinkage less than 0.1%.
- D. Acoustic Performance -
 1. Sound Transmission Class (STC) Ratings (ASTM C423):
 2. Metal-Framed Interior Partitions:
 - a. Partition Type A: Fire-Rated Interior Partitions.
 - 1) Fire-Rated Assembly and Rating:
 - (a) Partition Type A2: U.L. Design U469, 1-hour rated assembly.
 - (b) Partition Type A: U.L. Design U465, 1-hour rated assembly.
 - 2) Makeup: 5/8-inch Type X gypsum board each side of 20-gauge metal studs with SABs in stud cavity:
 - (a) 2-1/2 inch studs (Type 'A2') with 2-1/2 inch SABs: STC-47.**
 - (b) 3-5/8 inch studs (Type 'A') with 2-1/2 inch SABs: STC-47.**
 - b. Partition Type A, O, P, W: Non-Fire-Rated Interior Partitions.
 - 1) Makeup: 5/8-inch Type X gypsum board each side of metal studs with or without SABs in stud cavity:
 - (a) 1-5/8 inch studs without SABs: STC-38. **
 - (b) 2-1/2 inch studs without SABs: STC-40.**
 - (c) 3-5/8 inch studs without SABs: STC-39.**
 - (d) 3-5/8 inch studs with 2-1/2 inch SABs: STC-47.**
 - (e) 3-5/8 inch studs with 3-1/2 inch SABs: STC-46.**
 - c. Partition Type D: Fire-Rated Interior Partition.
 - 1) Wall Assembly per U.L. Design U411 (2-hour).
 - 2) Makeup: 2-layers of 5/8-inch Type X gypsum board each side of 20-gauge metal studs with SABs in stud cavity:
 - (a) 3-5/8 inch studs with 3-1/2 inch SABs: STC-56.**
 - d. Partition Type F1:
 - 1) Description: Fire-Rated Shaft Wall per U.L. Design U497 (2-hour).

- 2) Makeup: 1-inch shaftliner; 2-1/2 inch deep CH studs; and 2-layers of 5/8-inch Type X gypsum board:
 - (a) Partition without SABs: STC-41.**
 - (b) Partition with 1-1/2 inch SABs: STC-48.**
 - (c) Partition with resilient channels one side, with 1-1/2 inch SABs: STC-51.**
- e. Partition Type F1, F2, & F3:
 - 1) Fire-Rated Shaft Wall per U.L. Design U499 (1-hour).
 - 2) Makeup: 1-inch shaftliner; C-H shaped studs; 5/8-inch Type X gypsum board.
 - (a) 2-1/2 inch studs without SABs: STC-37.**
 - (b) 2-1/2 inch studs with 1-1/2 inch SABs: STC-42.**
 - (c) 4-inch studs with 3-1/2 inch SABs: STC-47.
 - (d) 6-inch studs with 3-1/2 inch SABs: STC-45.
- f. Partition Type E1: Chase Walls:
 - 1) Fire-Rated Chase Wall per U.L. Design U420 (1-hour).
 - 2) Makeup: 5/8-inch Type X gypsum board each side of double row of 1-5/8 inch studs spaced 24-inches on-center with gypsum board gussets:
 - (a) Wall with 3-1/2 inch SABs one side of wall: STC-52.
3. Wood-Framed Interior Partitions:
 - a. Partition Type []: Standard Interior Partitions:
 - 1) Fire-Rated Wall (If applicable): U.L. Design U305, 1-hour rated assembly.
 - 2) Makeup: 5/8-inch Type X gypsum board each side of wood studs with SABs in stud cavity:
 - (a) 2X4 studs with 3-1/2 inch SABs: STC-36.
 - (b) 2X4 studs with resilient channels one side, and 3-1/2 inch SABs: STC-51
 - (c) 2X4 studs, resilient channels each side, 2-1/2 SABs: STC-50.
 - b. Partition Type []: Standard Interior Partition:
 - 1) Fire-Rated Wall (If applicable): U.L. Design U301, 2-hour rated assembly.
 - 2) Makeup: 2-layers of 5/8-inch Type X gypsum board on each side of wood studs with SABs in stud cavity :
 - (a) 2X4 studs with 3-1/2 inch SABs: STC-41.
 - (b) 2X4 studs with resilient channels one side, and 3-1/2 inch SABs: STC-58.
 - c. Partition Type []: Chase Walls, Aligned:
 - 1) Fire-Rated Wall (If applicable): U.L. Design U341, 1-hour rated assembly.
 - 2) Makeup: 5/8-inch Type X gypsum board each side of double row 2X4 studs spaced 16-inches on-center on separate plates, studs aligned:
 - (a) Partition with 3-1/2 inch SABs one side: STC-51.
 - (b) Partition with 3-1/2 inch SABs both sides: STC-54.
 - d. Partition Type []: Chase Wall, Staggered:
 - 1) Fire-Rated Wall (If applicable): GA File Design WP-5515, 1-hour rated assembly.
 - 2) Makeup: 5/8-inch Type X gypsum board each side of double row 2X4 studs spaced 16-inches on-center, staggered 8-inches on-center on 2X6 plates:
 - (a) Wall with 3-1/2 inch SABs: STC-45.
 - e. Partition Type []: Chase Wall, Aligned
 - 1) Fire-Rated Wall (If applicable): U.L. Design WP-3820, 2-hour rated assembly.
 - 2) Makeup: 5/8-inch Type X gypsum board each side of double row 2X4 studs spaced 16-inches on-center on separate plates, studs aligned:
 - (a) Partition with 3-1/2 inch SABs one side: STC-51.
 - (b) Partition with 3-1/2 inch SABs both sides: STC-54.
 - f. Partition Type []: Chase Wall, Staggered:
 - 1) Fire-Rated Wall (If applicable): U.L. Design WP-5530, 2-hour rated assembly.
 - 2) Makeup: 2-layers of 5/8-inch Type X gypsum board each side of double row 2X4 studs spaced 16-inches on-center and staggered 8-inches on-center on 2X6 plates:

01-17-2022

(a) Partition with 3-1/2 inch SABs: STC-53.

2.07 GLASS-FIBER BLANKET (BATT) INSULATION

- A. Manufacturer: Owens Corning Insulating Systems, LLC.
- B. Glass-Fiber Blanket (Batt) Insulation, General:
 - 1. Insulation Width: Where indicated, provide 16-inch batts to fit stud spacing.
 - 2. Insulation Length: 48-inches or 96-inches.
 - 3. Facings:
 - a. Plenum Space: Where indicated, provide Aluminum foil, one side.
 - b. Non-Plenum Spaces: Where indicated, provide Asphalt treated Kraft paper, one side.
 - 4. Formaldehyde Content: Zero.
 - 5. Corrosiveness (ASTM C665): Passes.
 - 6. Fungi Resistance (ASTM C1338): Passes.
- C. Products:
 - 1. EcoTouch® Unfaced Thermal Batt Insulation: ASTM C665, Type I, preformed formaldehyde free glass fiber batt type, unfaced.
 - a. Physical Properties:
 - 1) Combustibility (ASTM E136): Non-combustible.
 - 2) Mold/mildew resistant per ASTM C138/C138M.
 - 3) Surface Burning Characteristics (ASTM E84): Flame Spread: 10; Smoke Developed Index: 10.
 - 4) Water Vapor Sorption (ASTM C1104): 5-percent by weight, maximum.
 - 5) Dimensional Stability: Less than 0.1-percent linear shrinkage.
 - 6) Maximum Use Temperature (ASTM C411): 450°F.
 - 2. EcoTouch® Kraft-Faced Thermal Batt Insulation: ASTM C 665, Type II, Class C preformed formaldehyde free glass fiber batt type, Kraft paper faced one side.
 - a. Physical Properties:
 - 1) Surface Burning Characteristics (ASTM E84): Not rated.
 - 2) Mold/mildew resistant per ASTM C138/C138M.
 - 3) Perm Rating (ASTM E96): 1 perm maximum.
 - 4) Water Vapor Sorption (ASTM C1104): 5-percent by weight, maximum.
 - 5) Dimensional Stability: Less than 0.1-percent linear shrinkage.
 - 3. EcoTouch® Foil-Faced Thermal Batt Insulation: ASTM C 665, Type III, Class C preformed formaldehyde free glass fiber batt type, foil faced one side.
 - a. Surface Burning Characteristics (ASTM E84): Flame Spread: 75; Smoke Developed Index: 150.
 - b. Perm Rating: 0.5 perm maximum per ASTM E96.
 - c. Water Vapor Sorption (ASTM C1104): 5-percent by weight, maximum.
 - d. Dimensional Stability: Less than 0.1-percent linear shrinkage.
 - 4. EcoTouch® FS-25 Thermal Batt Insulation: ASTM C 665, Type II (PSK facing), or Type III (FSK facing), Class A preformed formaldehyde free glass fiber batt, poly/scrim/Kraft (PSK) or foil/scrim/Kraft (FSK) faced on one side.
 - a. Flame Spread Index: Less than 25; Smoke Developed Index: Less than 50 per ASTM E84.
 - b. ICC building construction classification: all types.
 - c. Perm Rating: 0.02 maximum per ASTM E96.
- D. Metal-Framed Wall Construction:
 - 1. Insulation Thickness and Thermal Resistance (R-value): ASTM C518:
 - a. Interior wood-framed walls:
 - 1) Refer to "Acoustic Blanket Insulation" Article this Section
 - b. Exterior metal-framed walls with continuous insulation: 3-1/2 inches, R-13 (min.) in stud cavity to comply with 2015 IECC.

- 1) Refer to "Expanded Polystyrene (EPS) Insulation " Article this Section for continuous insulation requirements.
- E. Wood-Framed Wall Construction:
 1. Insulation Thickness and Thermal Resistance (R-value): ASTM C518:
 - a. Interior wood-framed walls:
 - 1) Refer to "Acoustic Blanket Insulation" Article this Section
 - b. Exterior wood-framed walls with continuous insulation:
 - 1) 3-1/2 inches, R-13 (min.) in stud cavity to comply with 2015 IECC.
 - 2) Refer to "Expanded Polystyrene (EPS) Insulation" Article this Section for continuous insulation requirements.
- F. Accessories: Provide accessories per insulating system manufacturer's recommendations, including the following:
 1. Tape: Polyethylene self-adhering type for Kraft faced insulation and bright aluminum self-adhering type for foil faced insulation.
 2. Insulation Fasteners: Impale clip of galvanized steel; type recommended by insulation manufacturer for particular use intended.
 3. Mechanical Insulation Fasteners: FM approved, corrosion resistant, size required to suit application.
 4. Wire Mesh: Galvanized steel, hexagonal wire mesh.
 5. Spindle Fasteners: Corrosion-resistant wire spindles.
 6. Ventilation Baffles: Formed plastic, metal, or cardboard sized to fit full width of rafter spaces.

2.08 MINERAL WOOL INSULATION

- A. Applications:
 1. Thermal and acoustical insulation.
 2. Perimeter fire containment systems.
 3. Fire resistive joint systems in rated assemblies.
 4. Firestopping of through penetrations in rated assemblies.
- B. Manufacturer: Thermafiber, Inc. (an Owens Corning company).
 1. Contacts: P: (888) 834-2371 / Web: www.thermafiber.com
- C. Mineral Wool Insulation at Non-Fire Rated Interior Walls and Ceilings:
 1. Product: VersaBoard 35, Semi-Rigid Mineral Wool Insulation Board.
 - a. Compliance: Non-combustible, semi-rigid mineral wool insulation board, water repellent, complying with ASTM C612, Type 1A.
 - b. Fire resistant to temperatures above 2,000 degrees F.
 - c. R-Value: 4.2 per inch.
 - d. Density: 3.5 pcf (actual).
 - e. Facing: Unfaced.
 - f. Board Thickness: 1-1/2 to 7-inches, in 1/2-inch increments.
 - g. Board Width: Where indicated, provide 24-inch or 36-inch.
 - h. Board Length: 48-inches or 60-inches.
 2. Acoustical Performance: In accordance with ASTM C423.
 3. Physical Properties:
 - a. Surface Burning Characteristics (ASTM E84):
 - 1) Unfaced: Smoke Developed: 0, Flame Spread: 0.
 - 2) Foil Faced: Smoke Developed: 0, Flame Spread: 25 or less.
 - b. Moisture Resistance (ASTM C1104): Absorption of less than 1.0-percent by volume.
 - c. Corrosivity (ASTM C665): Non-corrosive.
 - d. Fiber Type: Standard fiber; 70-percent pre-consumer recycled content.
 - e. Post-Consumer Recycled Content: 0 percent.
 - f. UL Certified Environmental Product Declaration in accordance with ISO 14025.
 4. Installation:

01-17-2022

- a. Interior stud cavities.
- b. Ceiling Overlayment:
- D. Mineral Wool Insulation at Fire-Rated Interior Walls and Ceilings:
 - 1. Product: Sound Attenuation Fire Blanket (SAFB), unfaced.
 - a. Compliance: Flexible or semi-rigid pre-formed batt or blanket, complying with ASTM C665, Type I (unfaced).
 - b. Formaldehyde Free (FF)
 - c. R-Value: 4.2 per inch.
 - d. Density:
 - 1) 1-inch thick: 4.0 pcf, nominal.
 - 2) Thicker than 1-inch: 2.5 pcf, nominal.
 - e. Facing: Unfaced.
 - f. Blanket Thickness:
 - 1) 2.5 pcf Density: 1-1/2 to 7-inches, in 1/2-inch increments.
 - 2) 4.0 pcf Density: 1-inch.
 - g. Blanket Width: Where indicated, provide 24-inch or 36-inch.
 - h. Blanket Length: 48-inches.
 - 2. Acoustical Performance: In accordance with ASTM C423.
 - 3. Physical Properties:
 - a. Surface Burning Characteristics (ASTM E84):
 - 1) Unfaced: Smoke Developed: 0, Flame Spread: 0.
 - b. Moisture Resistance (ASTM C1104): Absorption of less than 1.0-percent by volume.
 - c. Corrosivity (ASTM C665): Non-corrosive.
 - d. NFPA 101: Class A rated interior finish.
 - e. GREENGUARD GOLD Certified.
 - f. ULE Validated Formaldehyde Free.
 - g. Fiber Type: Standard fiber; 70-percent pre-consumer recycled content.
 - 4. Installation:
 - a. Interior Stud Cavities: Friction fit SAFB™ securely between studs. Butt ends of blankets closely together and fill all voids.
 - b. Ceiling Overlayment: Lay SAFB over ceiling panels extending 48-inches beyond all partitions. Tightly fit around all hangers, obstructions, and penetrations.

2.09 PERIMETER FIRE CONTAINMENT SYSTEMS

- A. General: Provide where indicated for gaps between the perimeter edge of fire-resistance-rated floor assemblies and non-fire-resistance-rated exterior curtain walls.
 - 1. Provide a perimeter fire-containment system with the fire test response characteristics indicated, as determined by testing identical systems per the Underwriters Laboratories or Intertek (OPL) Laboratories, or another testing and inspecting agency accountable to authorities having jurisdiction.
 - 2. If no tested system exists, an engineering judgment provided by the manufacturer, 3rd party testing lab, or fire protection engineering firm that follows guidelines established by the International Firestop Council must accompany the design.
 - 3. For non-fire resistance rated floor assemblies add an approved material or assembly for retarding the passage of flame and hot gasses.
- B. Curtain Wall Insulation:
 - 1. Applications:
 - a. Thermal and acoustical insulation.
 - b. Fire containment.
 - c. Vapor control.
 - 2. Manufacturer: Thermafiber, Inc. (an Owens Corning company).
 - a. Contacts: P: (888) 834-2371 / Web: www.thermafiber.com
 - 3. Products:
 - a. Thermafiber FireSpan 90 Insulation, mineral wool.

- 1) Compliance: ASTM C612, Type IA, IB, II, III, IVA.
- 2) Density: 8.0 pcf.
- 3) R-Value: 4.3 per inch.
- 4) Facing: Foil Faced.
- 5) Thickness: 1- to 7-inches, in 1/2-inch increments.
- 6) Width: Where indicated, provide 24-inch, 36-inch, or 72-inch.
- 7) Length: 48-, 60-, or 72-inches.
- b. Thermafiber FireSpan 40 Insulation, mineral wool.
 - 1) Compliance: ASTM C612, Type IA, IB, II, III, IVA.
 - 2) Density: 4.0 pcf.
 - 3) R-Value: 4.3 per inch.
 - 4) Facing: Foil Faced.
 - 5) Thickness: 2 to 7-inches, in 1/2-inch increments.
 - 6) Width: Where indicated, provide 24-inch, 36-inch, or 72-inch.
 - 7) Length: 48-, 60-, or 72-inches.
- c. Minimum thickness and density as noted in UL Design references on drawings
4. Physical Properties:
 - a. Surface-Burning Characteristics: Tested in accordance with ASTM E84:
 - 1) Unfaced: Maximum flame spread: 0, and smoke-developed: 0.
 - 2) Foil Faced: Maximum flame spread: 25, and smoke-developed: 0.
 - b. Corrosivity (ASTM C665): Non-corrosive.
 - c. Water Vapor Sorption (ASTM C1104): Less than 1 percent by volume.
 - d. Water Permeance (ASTM E96/E96M): Unfaced: 50 perms, Foil Faced: 0.02 Perms.
 - e. ASTM E136: Noncombustible, Passes.
- C. Safing Insulation:
 1. Manufacturer: Thermafiber, Inc. (an Owens Corning company).
 - a. Contacts: P: (888) 834-2371 / Web: www.thermafiber.com
 2. Product: "Thermafiber Safing Insulation", Mineral wool.
 - a. Type: Designated Type SAF in UL Fire Resistance Directory.
 - b. Facing: Unfaced.
 - c. Thickness: 1-1/2 to 7-inches, in 1/2-inch increments.
 - d. Width: Where indicated, provide 16-inch, 24-inch, or 36-inch.
 - e. Length: 48-inches or 60-inches.
 - f. Density: 4.0 pcf or 6.0 pcf (actual), as noted in UL Design references on drawings.
 3. Applications:
 - a. Perimeter Installation: Safing insulation should be compression fitted between the slab edge and the curtain wall insulation, leaving no voids.
 - b. Penetration Application: Safing insulation should be cut slightly larger than the opening and compression fitted into the opening, leaving no voids.
 - c. Construction Joint Application: Safing insulation should be compression fitted into the joint opening, leaving no voids.
 4. Performance:
 - a. Perimeter Fire Containment Tests (ASTM E2307):
 - 1) Aluminum Spandrel Curtain Wall Fire Containment
 - 2) Steel Stud-Framed / Gypsum Sheathing Curtain Wall Fire Containment
 - 3) Glass Spandrel Curtain Wall Fire Containment
 - 4) Granite Spandrel Curtain Wall Fire Containment
 - 5) Precast Concrete Spandrel
 5. Physical Properties:
 - a. Surface-Burning Characteristics (ASTM E84):
 - 1) Unfaced: Maximum Flame Spread: 0, Smoke Developed: 0.
 - b. Corrosivity (ASTM C665): Non-corrosive.
 - c. Fiber Type: Standard fiber; 70 percent pre-consumer recycled content
 - d. UL Certified Environmental Product Declaration in accordance with ISO 14025.

01-17-2022

D. Accessories:

1. Safing Clips: Z-Shaped galvanized steel clips formed from 1 inch wide strips of 20 gauge galvanized steel; 3 inches high with 2 inch and 3 inch upper and lower horizontal legs. Use where required by specific UL or OPL/Intertek design.
2. Hardware: Thermafiber Impasse hardware for attaching curtain wall insulation or other mechanical fasteners as approved by the Manufacturer.
3. Mullion Covers: Thermafiber FireSpan 90 Insulation for protection of mullions. Refer to specific UL/Intertek designs for size of mullion covers.
4. Backer / Reinforcement Member: Thermafiber Impasse T-Bar or galvanizes steel channel or angle (see specific listing for appropriate gauge of steel) approved by the primary manufacturer. Place horizontally at the safe-off line to support the curtain wall insulation to prevent bowing of curtain wall insulation caused by compression fitting of the Safing insulation. See specific listed design for system requirements.
5. Smoke Barrier: Smoke sealant as listed in the appropriate fire tested assembly.
6. Vapor Retarder Tape: Compatible with specified facer and comparable perm rating. For taping insulation joints and repairing tears.

2.10 FIRE RESISTIVE JOINT SYSTEMS IN RATED ASSEMBLIES

A. Insulation for Joint Packing:

1. Product for Construction Joints: Thermafiber Safing Insulation - Type SAF.
2. Product for Head of Wall Applications: Thermafiber Top-Stop Insulation.
3. Facing: Unfaced.
4. Surface Burning Characteristics: Flame Spread 0 and Smoke Developed 0; tested in accordance with ASTM E84.
5. Corrosivity: Non-corrosive, when tested in accordance with ASTM C665.
6. Fiber Type: Standard fiber; 70 percent pre-consumer recycled content
7. UL Certified Environmental Product Declaration in accordance with ISO 14025.
8. This product qualifies under the Department of Homeland Security SAFETY Act designation which provides commercial building professions and building owners liability protection in the event of a foreign/domestic act of terrorism.

B. Smoke Barrier Sealant: Smoke sealant as listed in the appropriate fire tested assembly.

2.11 FIRESTOPPING OF THROUGH PENETRATIONS IN RATED ASSEMBLIES

A. Safing Insulation: Refer to "Safing Insulation" Article above for requirements.

B. Smoke Barrier Sealant: Smoke sealant as listed in the appropriate fire tested assembly.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.

3.02 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated, and ASTM C1320.
- B. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- C. Provide continuous coverage of sound-attenuation batts within partitions. Confirm that batts remain friction fit within framing before enclosing.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.03 INSTALLATION - RIGID BOARD INSULATION

- A. Exterior Walls, Continuous Installation: Install insulation board vertically or horizontally over exterior sheathing. Fasten vertically 12 inches (300 mm) maximum on centers using fasteners

01-17-2022

recommended by manufacturer.

- B. Concrete and Masonry Walls: Install insulation board directly to exterior of concrete and unit masonry substrates as recommended by manufacturer.
 - 1. Remove jagged surfaces or surface irregularities prior to installation.
 - 2. Attach insulation by using polystyrene compatible adhesive or an approved mechanical fastener.
 - 3. Butt edges tightly.
- C. Cavity Walls: Install insulation board on exterior surface of interior wythe of cavity wall, fitting board between wall ties and other projections and penetrations without large gaps or openings.
 - 1. Remove jagged surfaces or surface irregularities prior to installation.
 - 2. Attach insulation in conformance with the applicable code.
 - 3. Maintain installed insulation to a point above the outer wythe as the work progresses to keep mortar from blocking the cavity.
 - 4. Maintain a space between the insulation and the inside face of the outer wythe of at least 3/4 inch.
 - 5. Stagger multiple layers of insulation. Butt edges tightly.
 - 6. Tape all horizontal and vertical joints in the insulation with PolyGard 136 tape.
- D. Below Grade:
 - 1. Protection Board and Perimeter Foundation Insulation: Install insulation board on exterior surface of perimeter foundation walls and footings.
 - a. Remove jagged surfaces or surface irregularities prior to installation.
 - b. Verify that damproofing or waterproofing is fully cured prior to application over such surfaces.
 - c. Attach insulation by pressing into cured damproofing or waterproofing or by using polystyrene compatible adhesive.
 - d. Butt edges tightly.
 - e. Apply polystyrene compatible sealant to the joint between the substrate and the insulation board to minimize water infiltration behind the insulation.
 - f. Do not allow insulation board to be exposed for an extended period of time to protect from UV exposure and damage from other trades.
 - g. Carefully backfill without displacing or damaging the insulation board.
 - 2. Under Slab-On-Grade: Install insulation board under slab-on-grade and over properly prepared subgrade of compacted fill and vapor retarder. Place insulation board with sides and ends butted.
 - a. Prepare subgrade by removing surface irregularities prior to installation.
 - b. Install vapor barrier over subgrade to protect against dampness and moisture penetration.
 - c. Butt edges tightly.
 - d. Do not allow insulation board to be exposed for an extended period of time to protect from UV exposure and damage from other trades.
 - e. Carefully install reinforcing and concrete without displacing or damaging the insulation board.

3.04 INSTALLATION - BATT INSULATION

- A. Friction-fit blanket insulation in place, until the interior finish is applied. Install batts to fill entire stud cavity, with no gaps, voids, or areas of compression. If stud cavity is less than 8 feet in height, cut lengths to friction fit against floor and ceiling tracks. Walls with penetrations require that insulation be carefully cut to fit around outlets, junction boxes, and other irregularities.
 - 1. Do not install insulation on top of or within 3 inches of recessed light fixtures unless the fixtures are approved for such use.
- B. Within exterior wall framing, install insulation between pipes and backside of sheathing. Cut or split insulation material as required to fit around wiring and plumbing.
- C. If eave ventilation baffles are required, install ventilation baffles at eaves to hold insulation down from roof sheathing and provide positive ventilation from eave to attic space.

01-17-2022

- D. Fluff insulation to full thickness for specified R-value before installation. Do not compress insulation in the cavity during installation, creating gaps or voids that could diminish thermal value.
- E. Trim insulation neatly to fit spaces. Fill miscellaneous gaps and voids with insulation.
- F. Fit insulation tight in spaces and tight to exterior side of mechanical and electrical services within the plane of insulation.
- G. For unfaced batt insulation, install with friction fit or retain in place with manufacturer's recommended fasteners or mesh.
- H. For batt insulation with factory-applied facing, install with vapor retarder membrane facing warm in the winter side of building spaces or as specified by local building code. Lap ends and side flanges of membrane over or between framing members. Tape to seal tears, cuts or misalignments in membrane.
- I. Secure insulation in place using one of the following methods: Friction fit; staple or nail facing flanges in place as needed, tape in place, retain in place with spindle fasteners, retain in place with wire mesh secured to framing members.
- J. Retain insulation batts in place with wire mesh secured to framing members where insulation will be exposed.

3.05 INSTALLATION - PERIMETER FIRE CONTAINMENT SYSTEMS

- A. Comply with tested and listed systems. Install products in proper relationship with each other and adjacent construction and as follows:
 - 1. Backer Reinforcement Members for Perimeter Fire Containment System:
 - a. Install backer reinforcement member in accordance with the listed tested system.
 - b. Install Thermafiber Impasse T-Bar or an approved light steel angle or channels (see specific listing for appropriate gauge of steel), placed horizontally at the safig line, attached to the vertical mullions either within the insulation at a horizontal splice, or behind the insulation and mechanically attached to vertical mullions.
 - c. Install to prevent the bowing of the curtain wall insulation due to the compression fit of the safig insulation.
 - 2. Curtain Wall Insulation:
 - a. Install curtain wall insulation in accordance with Underwriters Laboratories / Intertek (OPL) Laboratories listed system and manufacturer's instructions.
 - b. Install backer bar assembly in accordance with the listed and tested design. Not applicable when the Thermafiber No Backer Bar system is specified.
 - c. Fasten insulation in place with mechanical fasteners within the mullions and transoms (spandrel area), spaced at intervals recommended by listed and tested assembly to hold insulation securely in place without touching the exterior wall. One inch air space must be maintained.
 - d. Provide Thermafiber Impasse hardware or mechanical fasteners as approved by Architect and manufacturer.
 - e. Comply with specific listed and tested assemblies for mechanical fastener requirements.
 - f. Maintain cavity width of dimension indicated between insulation and exterior wall.
 - 3. Safing Insulation - Type SAF:
 - a. Install safig insulation of proper size in safe off area between curtain wall insulation and floor slab as prescribed by the listed and tested assembly. Safing insulation direction and compression as well as the absence of safig Z-clips are prescribed by the listed and tested assembly.
 - b. Install safig insulation of proper density and size into perimeter joint, construction joints (head-of-wall, floor-to-floor, floor-to-wall, etc.) as prescribed by the listed and tested assembly.
 - c. Install safig insulation of proper density and size into poke-throughs and penetrations as prescribed by the listed and tested assembly.
 - 4. Smoke Barrier System:

- a. Utilize foil faced FireSpan curtain wall Insulation with Thermafiber Safing Insulation.
 - b. Apply approved smoke sealant in accordance with the tested assembly.
 - c. Install safing insulation of proper density and size as prescribed by the listed and tested assembly.
 - d. Install safing insulation of proper density and size into poke-throughs and penetrations as prescribed by the tested assembly.
 - e. Apply approved smoke sealant in accordance with the tested assembly.
5. Vapor Retarders:
- a. Seal all joints in curtain wall insulation or exterior wall insulation with vapor retarder tape.
 - b. Application of vapor retarder must be directed by Architect of Record or Mechanical Engineer of project.
 - c. For continuous vapor barrier repair all tears in insulation foil facing with vapor retarder tape.

3.06 PROTECTION

- A. Protect installed insulation from damage due to weather and physical abuse until protected by permanent construction.

END OF SECTION 07 21 00

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SECTION 07 24 00
EXTERIOR INSULATION AND FINISH SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Composite wall cladding of rigid insulation and reinforced finish coating ("Class PB").
- B. Drainage and water-resistive barriers behind insulation board.

1.03 RELATED SECTIONS

- Section 05 40 00 - Cold-Formed Metal Framing.
- Section 06 10 00 - Rough Carpentry.
- Section 06 16 00 - Glass-Mat Gypsum Sheathing
- Section 07 62 00 - Sheet Metal Flashing and Trim.
- Section 07 92 00 - Joint Sealants.

1.04 REFERENCES

- A. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus 2019.
- B. ASTM C150/C150M - Standard Specification for Portland Cement 2021.
- C. ASTM C297/C297M - Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions 2016.
- D. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation 2019.
- E. ASTM C1063 - Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster 2021.
- F. ASTM C1397 - Standard Practice for Application of Class PB Exterior Insulation and Finish Systems (EIFS) and EIFS with Drainage 2013 (Reapproved 2019).
- G. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds 2020.
- H. ASTM D968 - Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive 2017.
- I. ASTM D2247 - Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity 2015 (Reapproved 2020).
- J. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber 2016.
- K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- L. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference 2014 (Reapproved 2021).
- M. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference 2000 (Reapproved 2016).
- N. ASTM E2273 - Standard Test Method for Determining the Drainage Efficiency of Exterior Insulation and Finish Systems (EIFS) Clad Wall Assemblies 2018.
- O. ASTM E2485/E2485M - Standard Test Method for Freeze/Thaw Resistance of Exterior Insulation and Finish Systems (EIFS) and Water Resistive Barrier Coatings 2013 (Reapproved 2018).

01-17-2022

- P. ASTM E2486/E2486M - Standard Test Method for Impact Resistance of Class PB and PI Exterior Insulation and Finish Systems (EIFS) 2013 (Reapproved 2018).
- Q. ASTM G153 - Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials 2013 (Reapproved 2021).
- R. ASTM G155 - Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials 2021.
- S. ISO 9001 - Quality management systems -- Requirements 2015.
- T. NFPA 268 - Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source 2022.
- U. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components 2019.

1.05 DEFINITIONS

- A. Base Coat: Material used to encapsulate one or more layers of reinforcing mesh fully embedded that is applied to the outside surface of the EPS.
- B. Building Expansion Joint: A joint through the entire building structure designed to accommodate structural movement.
- C. EIFS: Exterior Wall Insulation and Finish System.
- D. Expansion Joint: A structural discontinuity in the EIFS.
- E. Finish: An acrylic-based coating that is applied over the base coat.
- F. Insulation Board: Expanded polystyrene (EPS) insulation board, which is affixed to the sheathing substrate and creates a layer of continuous insulation.
- G. Reinforcing Mesh: Glass fiber mesh(es) used to reinforce the base coat and to provide impact resistance.
- H. Sheathing: The substrate to which the EIFS is affixed.

1.06 SYSTEM DESCRIPTION

- A. General: Exterior Insulation and Finish System (EIFS), Class PB, consisting of an air/water-resistive barrier, an adhesive, grooved expanded polystyrene insulation board, flashings and trim, base coat, reinforcing mesh(es) and finish.
- B. Method of Installation
 - 1. Field Applied: The Outsulation MD System is applied to the substrate system in place.
- C. Design Requirements:
 - 1. Sheathing Substrate: Refer to Section 06 16 00.
 - 2. All areas requiring an impact resistance classification higher than "standard", as defined by ASTM E2486/E2486M, shall be as detailed in the drawings and described in the contract documents.
 - 3. Terminations
 - a. Prior to applying the system, wall openings shall be treated with a Flashing System or Flashing Tape.
 - b. The system shall be held back from adjoining materials around openings and penetrations such as windows, doors, and mechanical equipment a minimum of 3/4-inches for sealant application.
 - c. The system shall be terminated a minimum of 8-inches above finished grade.
 - 4. Sealants
 - a. Shall be manufactured and supplied by others.
 - b. Shall be compatible with the system materials.
 - c. The sealant backer rod shall be closed cell.
 - 5. Flashing: Shall be provided at all roof-wall intersections, windows, doors, and other areas as necessary to prevent water from entering behind the EIFS.

01-17-2022

1.07 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on system materials, product characteristics, performance criteria, and system limitations.
- C. Shop Drawings: Include plans, elevations, sections, details of components, details, penetrations, terminations, joints, fasteners, and attachments to other work.
- D. Selection Samples: Submit manufacturer's standard range of samples illustrating available coating colors and textures.
- E. Verification Samples: Submit actual samples of selected coating on specified substrate, minimum 12 inches (300 mm) square, illustrating project colors and textures.
- F. Manufacturer's Installation Instructions: Indicate preparation required, installation techniques, and jointing requirements.

1.08 QUALITY ASSURANCE

- A. Maintain copy of specified installation standard and manufacturer's installation instructions at project site during installation.
- B. EIFS Manufacturer Qualifications: Provide EIFS products other than insulation from the same manufacturer with qualifications as follows:
 - 1. Member in good standing of EIMA (EIFS Industry Members Association).
 - 2. Manufacturer of EIFS products for not less than 5 years.
 - 3. Manufacturing facilities ISO 9001 certified.
- C. Insulation Manufacturer Qualifications: Approved by manufacturer of EIFS and approved and labeled under third party quality program as required by applicable building code.
- D. Installer Qualifications: Company specializing in the type of work specified and with at least three years of documented experience.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to project site in manufacturer's original, unopened containers with labels intact. Inspect materials and notify manufacturer of any discrepancies.
- B. Storage: Store materials as directed by manufacturer's written instructions.
 - 1. Protect insulation materials from exposure to sunlight.

1.10 FIELD CONDITIONS

- A. Do not prepare materials or apply EIFS under conditions other than those described in the manufacturer's written instructions.

1.11 SEQUENCING AND SCHEDULING

- A. Installation of the EIFS shall be coordinated with other construction trades.
- B. Sufficient manpower and equipment shall be employed to ensure a continuous operation, free of cold joints, scaffold lines, texture variations, etc.

1.12 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide manufacturer's shall provide a written moisture drainage and limited materials warranty against defective material, for a period of 5 years from the Date of Substantial Completion.
- C. Provide separate warranty from installer covering workmanship for a period of 1 year from the Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Manufacturer: Subject to compliance with the Contract Documents, provide an exterior wall insulation and finish system (EIFS) from Dryvit Systems, Inc.

01-17-2022

- B. Other Manufacturers: The following manufacturers are approved to provide materials or products that are equivalent to the "Basis of Design":
 - 1. Parex USA, Inc.
 - 2. Sto Corporation.
 - 3. Senergy (Degussa Wall Systems, Inc.)
 - 4. TEC (H.B. Fuller).
 - 5. Pleko, LLC.
- C. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Basis of Design Product:
 - 1. Dryvit Systems, Inc; Dryvit Outsulation Plus MD EIFS, Class PB with Engineered Moisture Drainage: www.dryvit.com/#sle.

2.02 EXTERIOR INSULATION AND FINISH SYSTEM

- A. Exterior Insulation and Finish System: DRAINAGE type; reinforced finish coating on mechanically-fastened grooved insulation board over water-resistive coating over substrate.
 - 1. Basis of Design: Dryvit Outsulation Plus MD EIFS, Class PB with Moisture Drainage.
- B. All components of the Outsulation MD System shall be supplied or obtained from Dryvit or its authorized distributors. Substitutions or additions of materials other than specified will void the warranty.

2.03 PERFORMANCE REQUIREMENTS

- A. Wind Loading: Withstand positive and negative wind loads as specified by the building code, when tested in accordance with ASTM E330/E330M.
- B. Fire Characteristics:
 - 1. Flammability: Pass, when tested in accordance with NFPA 285.
 - 2. Ignitibility: No sustained flaming when tested in accordance with NFPA 268.
 - 3. Fire Resistance: Complies with fire resistance requirements indicated on the drawings as part of an exterior non-load-bearing exterior wall assembly when tested in accordance with NFPA 285.
- C. Adhesion of Water-Resistive Coating to Substrate: For each combination of coating and substrate, minimum flatwise tensile bond strength of 15 psi (105 kPa), when tested in accordance with ASTM C297/C297M.
- D. Water Penetration Resistance: No water penetration beyond the plane of the base coat/insulation board interface after 15 minutes, when tested in accordance with ASTM E331 at 2.86 psf (137 Pa).
- E. Drainage Efficiency: Average minimum efficiency of 90 percent, when tested in accordance with ASTM E2273 for 75 minutes.
- F. Salt Spray Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating after 300 hours exposure in accordance with ASTM B117.
- G. Freeze-Thaw Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating after 60 cycles, when tested in accordance with ASTM E2485/E2485M.
- H. Weathering Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating after 2000 hours of accelerated weathering conducted in accordance with ASTM G155 Cycle 1.
- I. Water Degradation Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating after 14 days exposure, when tested in accordance with ASTM D2247.
- J. Mildew Resistance: No growth supported on finish coating during 28 day exposure period, when tested in accordance with ASTM D3273.

01-17-2022

- K. Abrasion Resistance of Finish: No cracking, checking or loss of film integrity when tested in accordance with ASTM D968 with 528 quarts (500 liters) of sand.
- L. Impact Resistance: Construct system to provide the following impact resistance without exposure of broken reinforcing mesh, when tested in accordance with ASTM E2486/E2486M:
 - 1. Standard: 25 to 49 in-lb (2.83 to 5.54 J), for areas above those that receive high-impact resistance.
 - 2. Medium: 50 to 89 in-lb (5.65 to 10.1 J), for areas indicated on drawings.
 - 3. High: 90 to 150 in-lb (10.2 to 17 J), for areas from finished grade to 8'-0" above finished floor elevation.

2.04 MATERIALS

- A. Portland Cement: Shall be Type I or II, meeting ASTM C150/C150M, white or gray in color, fresh and free of lumps.
- B. Water: Shall be clean and free of foreign matter.

2.05 COMPONENTS

- A. Finish Coating Top Coat: Water-based, air curing, acrylic finish with integral color and texture.
 - 1. Texture: Dryvit Systems, Inc, Medallion Series PMR™ (Proven Mildew Resistance): Water-based, acrylic finish with integral color and texture and formulated with PMR chemistry.
 - a. Quarzputz PMR.
 - 2. Color: As selected by Architect from manufacturer's standard range to match existing.
- B. Reinforcing Mesh: Balanced, open-weave glass-fiber fabric; complying with ASTM D578 and the following:
 - 1. Standard-Impact Reinforcing Mesh: Not less than 4.0 oz./sq. yd. (136 g/sq. m).
 - 2. Intermediate-Impact Reinforcing Mesh: Not less than 10 oz./sq. yd. (339 g/sq. m)) [12.0 oz./sq. yd. (407 g/sq. m).
 - 3. Heavy-Duty Reinforcing Mesh: Not less than 20 oz./sq. yd. (678 g/sq. m).
 - 4. Strip Reinforcing Mesh: Not less than 3.75 oz./sq. yd. (127 g/sq. m).
 - 5. Detail Reinforcing Mesh: Not less than 4.0 oz./sq. yd. (136 g/sq. m).
 - 6. Corner Reinforcing Mesh: Not less than 7.2 oz./sq. yd. (244 g/sq. m).
- C. Base Coat: Shall be compatible with the EPS insulation board and reinforcing mesh(es).
 - 1. Cementitious: A liquid polymer-based material, which is field mixed with Portland cement.
 - a. Shall be Primus or Genesis
 - 2. Noncementitious: A factory-mixed, fully formulated, water-based product.
 - a. Shall be NCB
 - 3. Ready mixed: A dry blend cementitious, copolymer-based product, field mixed with water.
 - a. Shall be Primus DM, Genesis DM, Genesis DMS, Rapidry DM 35-50 or Rapidry DM 50-75.
- D. Dryvit Vent Track:
 - 1. A "J" shaped track complying with ASTM D1784 and ASTM C1063 containing a slot for drainage and located above the Dryvit Vent Assembly, along the base of walls and horizontal terminations.
- E. Dryvit Track:
 - 1. A "J" shaped track complying with ASTM D1784 and ASTM C1063 located above the Dryvit Starter Strip.
- F. Dryvit AP Adhesive™: A moisture cure urethane-based adhesive used to attach the Dryvit Track and Vent Track to the Backstop NT.
- G. Dryvit Vent Assembly:
 - 1. A 2-inch x 6-inch x 12-inch (51 mm x 152 mm x 305 mm) piece of aged expanded polystyrene, which is configured to contain a formed aggregate matrix material and receive the Dryvit Vent Track. It is required at the base of walls and the base of horizontal terminations and is capable of draining water.

01-17-2022

- H. Starter Strip:
 - 1. A 2-inch x 6-inch x 48-inches (51 mm x 152 mm x 1.2 m) piece of aged expanded polystyrene configured to receive the Dryvit Track™ and Vent Track™. It is required at the base of all walls, at base of horizontal terminations, and heads of windows and other openings.
- I. Machine Coated Dryvit EPS Shapes and Starter Boards.
- J. Insulation Board Closure Blocks: Expanded Polystyrene meeting Dryvit Specification for Insulation Board. The Closure Blocks shall measure a minimum of 6 in (152 mm) in height.
- K. Insulation Board: Expanded Polystyrene (EPS) Board Insulation: Complies with ASTM C578.
 - 1. The insulation board shall be manufactured by a board supplier approved by the manufacturer.
 - 2. Grooved Board: The back side of the insulation board shall have 1/4-inch x 1-inch (6.4 mm x 25 mm) grooves running vertically and spaced 12 in (305 mm) on center
 - 3. Board Size: As recommended by EIFS finish manufacturer.
 - 4. Board Size Tolerance: Plus/minus 1/16 inch (1.5 mm) from square and dimension.
 - 5. Board Thickness: As indicated on drawings, 2-inches minimum.
 - 6. Board Edges: Square.
 - 7. Foam Shapes: Provide with profiles and dimensions indicated on Drawings.
 - 8. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/450, when tested in accordance with ASTM E84.
- L. Adhesives: Used to adhere the EPS to the air/water-resistive barrier, shall be compatible with the air/water- resistive barrier and the EPS.
 - 1. Cementitious: A liquid polymer-based material, which is field mixed with Portland cement.
 - a. Shall be Primus or Genesis.
 - 2. Ready mixed: A dry blend cementitious, copolymer-based product, field mixed with water.
 - a. Shall be Primus® DM, Genesis® DM, Genesis® DMS, Rapidry DM 35-50 or Rapidry DM 50-75
- M. Flashing Materials: Used to protect substrate edges at terminations.
 - 1. Liquid Applied: An extremely flexible water-based polymer material, ready for use.
 - a. Shall be AquaFlash and AquaFlash Mesh
 - 2. Sheet Type:
 - a. Shall be Flashing Tape and Surface Conditioner
 - 1) Dryvit Flashing Tape™: A high density, polyethylene film backed with a rubberized asphalt adhesive available in rolls 4 in (102 mm), 6 in (152 mm) and 9 in (229 mm) wide by 75 ft (23 m) long.
 - 2) Dryvit Flashing Tape Surface Conditioner™: A water-based surface conditioner and adhesion promoter for the Dryvit Flashing Tape.
- N. Air/Water-Resistive Barrier Components:
 - 1. Dryvit Air/Water-Resistive Barrier Coating: Fluid-applied air and water barrier membrane applied to sheathing.
 - 2. Dryvit Backstop NT-Texture (BSNT-T): A vapor permeable, flexible, polymer-based noncementitious water-resistive and air barrier coating.
 - a. All sheathing substrate joints must be treated with Dryvit Grid Tape and BSNT-T prior to application of BSNT-T over the full sheathing surface.
 - 3. Dryvit Grid Tape™: An open weave fiberglass mesh tape with pressure sensitive adhesive available in rolls 4 in (102 mm) wide by 100 yds (91 m) long.
- O. Sheathing Board: Refer to Section 06 16 00.

2.06 ACCESSORY MATERIALS

- A. Insulation Fasteners: Fastener and plate system appropriate for substrate and as recommended by EIFS manufacturer.
- B. Metal Flashings: As specified in Section 07 62 00.

01-17-2022

- C. Trim: EIFS manufacturer's standard PVC or galvanized steel trim accessories, as required for a complete project and including starter track and drainage accessories.
- D. Sealant Materials: Compatible with EIFS materials and as recommended by EIFS manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate is sound and free of oil, dirt, other surface contaminants, efflorescence, loose materials, or protrusions that could interfere with EIFS installation and is of a type and construction that is acceptable to EIFS manufacturer. Do not begin work until substrate and adjacent materials are complete and thoroughly dry.
- B. Verify that substrate surface is flat, with no deviation greater than 1/4 in (6 mm) when tested with a 10 ft (3 m) straightedge.

3.02 PREPARATION

- A. Apply primer to substrate as recommended by EIFS manufacturer for project conditions.

3.03 INSTALLATION - GENERAL

- A. Install in accordance with EIFS manufacturer's instructions and ASTM C1397.
 - 1. Where different requirements appear in either document, comply with the most stringent.
 - 2. Neither of these documents supercedes provisions of Contract Documents that defines contractual relationships between parties or scope of this work.

3.04 AIR/WATER-RESISTIVE BARRIER INSTALLATION

- A. Apply barrier coating as recommended by coating manufacturer; prime substrate as required before application.
- B. Seal substrate transitions and intersections with other materials to form continuous water-resistive barrier on exterior of sheathing, using method recommended by manufacturer.
- C. At door and window rough openings and other wall penetrations, seal water-resistive barrier and flexible flashings to rough opening before installation of metal flashings, sills, or frames, using method recommended by manufacturer.
- D. At moving expansion joints, apply flexible flashing or flashing tape across and recessed into joint with U-loop forming continuous barrier but allowing movement.
- E. Lap flexible flashing or flashing tape at least 2 inches (50 mm) on each side of joint or transition.
- F. Install drainage layer or spacers after flashing tape has been completed.

3.05 INSULATION INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Prior to installation of boards, install starter track and other trim level and plumb and securely fastened. Install only in full lengths, to minimize moisture intrusion; cut horizontal trim tight to vertical trim.
- C. Install back wrap reinforcing mesh at all openings and terminations that are not to be protected with trim.
- D. Place boards in a method to maximize tight joints. Stagger vertical joints and interlock at corners. Butt edges and ends tight to adjacent board and to protrusions. Achieve a continuous flush insulation surface, with no gaps in excess of 1/16 inch (1.6 mm).
- E. Fill gaps greater than 1/16 inch (1.6 mm) with strips or shims cut from the same insulation material.
- F. Rasp irregularities off surface of installed insulation board.
- G. Cut aesthetic reveals in outside face of insulation with high-speed router and bit configured to produce grooves, rabbets, and other features that comply with profiles and locations indicated.

Do not reduce insulation thickness at aesthetic reveals to less than 3/4 inch (19 mm).

- H. Expansion Joints: Install at locations indicated, where required by EIFS manufacturer, where expansion joints are indicated in substrates behind EIFS; where EIFS adjoin dissimilar substrates, materials, and construction; and where wall height changes.
- I. Mechanical Fastening: Space fasteners as recommended by EIFS manufacturer.
- J. Adhesive Attachment: Use method required by manufacturer to achieve drainage efficiency specified; do not close up drainage channels when placing insulation board.

3.06 CLASS PB FINISH INSTALLATION

- A. Base Coat: Apply in thickness as necessary to fully embed reinforcing mesh, wrinkle free, including back-wrap at terminations of EIFS. Install reinforcing fabric as recommended by EIFS manufacturer.
 - 1. Lap reinforcing mesh edges and ends a minimum of 2-1/2 inches (64 mm).
 - 2. Allow base coat to dry a minimum of 24 hours before next coating application.
- B. Reinforcing Mesh: Completely embed mesh in wet base coat, applying additional base-coat material if necessary, so reinforcing-mesh color and pattern are not visible.
 - 1. Standard-impact reinforcing mesh for all walls above the heavy-duty reinforcing mesh.
 - 2. Intermediate-impact reinforcing mesh where indicated.
 - 3. Heavy-duty reinforcing mesh from ground level up to 8'-0" above finish floor elevation for all walls.
- C. Finish Coat: Apply finish coat after base coat has dried not less than 24 hours, embed finish aggregate, and finish to a uniform texture and color.
 - 1. Finish Coat Thickness: As recommended by manufacturer.
- D. Seal control and expansion joints within the field of exterior finish and insulation system, using procedures recommended by sealant and finish system manufacturers.

3.07 FIELD QUALITY CONTROL

Delete this article if not applicable. The International Building Code requires special inspections for some EIFS installations; verify requirements of applicable building code.

- A. Special Inspections: Developer may engage a qualified special inspector to perform any special inspections required by local jurisdictions:
- B. EIFS Tests and Inspections: For the following:
 - 1. According to ICC-ES AC24 or ICC-ES AC235.
- C. Remove and replace EIFS where test results indicate that EIFS does not comply with specified requirements.
- D. Prepare test and inspection reports.

3.08 CLEANING

- A. Clean EIFS surfaces and work areas of foreign materials resulting from EIFS operations.

3.09 PROTECTION

- A. Protect completed work from damage and soiling by subsequent work.

END OF SECTION 07 24 00

SECTION 07 27 26
FLUID-APPLIED VAPOR-PERMEABLE MEMBRANE AIR BARRIERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Fluid-applied, vapor-permeable membrane air barriers for use over glass mat gypsum wall sheathing and other substrates indicated.

1.03 RELATED REQUIREMENTS

- A. Section 06 16 00 - Sheathing
- B. Section 07 62 00 - Sheet Metal Flashing and Trim
- C. Section 07 92 00 - Joint Sealants

1.04 REFERENCES

- A. American Association of Textile Chemists and Colorists (AATCC) Test Method 127. "Water Resistance - Hydrostatic Pressure Test"
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1-2010 "Energy Standard for Buildings Except Low-Rise Residential Buildings"
- C. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants
- D. ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension
- E. ASTM D 1970 - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep slope roofing Underlayment for Ice Dam Protection.
- F. ASTM D 4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- G. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E 96 - Standard Test Methods for Water Vapor Transmission of Materials.
- I. ASTM E 331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
- J. ASTM E 783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
- K. ASTM E 1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference
- L. ASTM E 1354 - Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter
- M. ASTM E 2178 - Standard Test Method for Air Permeance of Building Materials
- N. ASTM E 2357 - Standard Test Method for Determining Air Leakage of Air Barrier Assemblies
- O. National Fire Protection Association (NFPA) 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

1.05 SUBMITTALS

- A. Product Data: Manufacturer's technical data sheets and safety data sheets for product and accessories.
- B. Product certificates.
- C. Product test reports.

- D. Shop Drawings:
 - 1. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
- E. Free film sample of product at representative cured thickness, minimum 2 inch by 3 inch size.
- F. Sample of sheet detail flashing, minimum 2 inch by 3 inch size.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Shall be experienced in applying the same or similar materials and shall be specifically approved in writing by Manufacturer.
- B. Single-Source Responsibility: Obtain product and accessories from single manufacturer.
- C. Product and Accessories shall comply with all state and local regulations controlling use of volatile organic compounds (VOCs).
- D. Mock-Ups: Prior to installation on Project, apply product and accessories on mock-up to verify details under shop drawing submittals, to demonstrate tie-ins with adjoining construction and other termination conditions and to become familiar with properties of materials in application:
- E. Cooperate and coordinate with the Owner's inspection and testing agency. Do not cover any installed product unless it has been inspected, tested and approved.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product, lot number and directions for storage.
- B. Store materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by manufacturer.
- C. During cold weather, maintain product temperature within acceptable range for application, as required by air barrier manufacturer. Protect freeze-sensitive materials from freezing.

1.08 PROJECT CONDITIONS

- A. Do not apply product or accessories during rain or accumulating snowfall.
- B. Apply product and accessories within approved ambient and substrate temperature range stated in manufacturer's literature.
- C. Do not apply product or accessories over incompatible materials.
- D. Observe safety and environmental measures indicated in manufacturer's SDS, and mandated by federal, state and local regulations.

1.09 WARRANTY

- A. The manufacturer shall warrant the product against material defects, or defects in manufacturing for Five (5) years from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Manufacturer: Products from Carlisle Coatings & Waterproofing, Inc are specified to establish a standard of quality for design, function, materials, and appearance.
- B. Other Manufacturers: The following manufacturers are approved to provide materials or products that are equivalent to the "Basis of Design":
 - 1. Grace, W. R., & Co. - Conn.; Perm-A-Barrier VP.
 - 2. Henry Company; Air-Bloc 31.
 - 3. Rubber Polymer Corporation, Inc.; Rub-R-Wall Airtight VP.
 - 4. Tremco Incorporated, an RPM company; ExoAir 230.
- C. Substitutions: Equivalent products complying with specified requirements will be considered, provided a manufacturer submit a request for consideration to the Architect prior to date established for receiving bids.

01-17-2022

2.02 VAPOR-PERMEABLE MEMBRANE AIR-BARRIER

- A. General:
 - 1. Air barrier shall be capable of performing as a continuous vapor- permeable air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration.
 - 2. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Performance Requirements:
 - 1. Product shall be minimum 0.013 inch (13mils) dry thickness membrane on exterior sheathing and minimum 0.026 inch (26 mils) dry thickness membrane on concrete and masonry. Dry membrane thickness shall be calculated based on field-measured wet mil thickness using a comb gauge and volume % solids of the product.
 - 2. Product shall be a high-solids, low VOC, moisture-curing material: silane terminated polyether (STPE), polyurethane or silicone chemistry with minimum 80% solids by volume and maximum 100g/L VOC
 - 3. Installed product and accessories shall have an upper service temperature limit of 180°F or higher.
 - 4. Manufacturer shall provide product and accessories which have a minimum installation temperature of 15°F or lower.
 - 5. Performance:
 - a. Air Permeance: ASTM E2178: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference.
 - b. Vapor Permeance: ASTM E96/E96M: Minimum 10 perms (70 g/m2/24h) when tested to water method (B).
 - c. Tensile Strength: ASTM D412:100 lbs/sq. in., minimum.
 - d. Tensile Elongation: ASTM D412: Minimum 200 percent.
 - e. Water Resistance: AATCC Test Method 127: Product over CMU substrate and over gypsum sheathing with joint shall resist a 55 cm (22 inch) column of water for 5 hours, no leaking or wet through.
 - f. Surface Burning: ASTM E84: Flame Spread Index: 25, Smoke Generation Index: 450.

2.03 ACCESSORIES

- A. General: Provide from same manufacturer as air barrier membrane.
- B. Sheet Detail Flashing: Foil composite faced rubberized asphalt flashing, minimum 0.040 inch (40 mils) thickness.
 - 1. Fire-Resist 705 FR-A or Fire-Resist 705 FR-A LT low temperature application formula by Carlisle Coatings & Waterproofing, Incorporated
 - 2. Others as approved by air barrier membrane manufacturer
- C. Contact Adhesive:
 - 1. Carlisle Coatings & Waterproofing, Incorporated:
 - a. Over approved wall substrates: CCW-702 Solvent-Based, CCW-702 LV VOC Compliant Solvent-Based, CCW-702 WB Water-Based, CAV-GRIP™ Aerosol Spray or Travel-Tack portable aerosol spray cans
 - b. Over cured liquid air barrier: CAV-GRIP™ Aerosol Spray or Travel-Tack portable aerosol spray cans
 - 2. Others as approved by air barrier membrane manufacturer
- D. Liquid Detail Flashing. Silane-terminated polyether, minimum 80% solids.
 - 1. Barribond trowel-applied at minimum 40 wet mils thickness
 - 2. Barrithane VP roller or brush-applied at minimum 40 wet mils thickness, all cracks and gaps exceeding 1/16 inch filled with detail sealant or fill compound struck flush.
 - 3. Others as approved by air barrier membrane manufacture

01-17-2022

- E. Detail Sealant: Silane-terminated polyether, minimum 90% solids, ASTM C 920 Type S, Grade NS, Class 25, Use NT.
 - 1. Barribond by Carlisle Coatings & Waterproofing, Incorporated
 - 2. Others as approved by air barrier membrane manufacturer
- F. Fill Compound: 2-part, non-sag polyurethane sealant
 - 1. Carlisle Coatings & Waterproofing, Incorporated: CCW-201
 - 2. Others as approved by air barrier membrane manufacturer

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions affecting installation of the air & vapor barrier and accessory products for compliance with requirements. Verify that surfaces and conditions are suitable prior to commencing Work of this section. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Verify that wall assemblies are dried in, such that water intrusion will not occur from above, behind or around the air barrier installation.
- C. Concrete and masonry shall be cured for a minimum of three days. It shall be smooth, with sharp protrusions such as form joints or fins removed and ground flush. Honeycomb and holes/cracks shall be filled with grout or mortar.
- D. Surfaces shall be sound, dry and free of oil, grease, dirt, excess mortar or other contaminants.
- E. Surfaces shall be supported and flush at joints without large voids or sharp protrusions.
- F. Mortar joints shall be struck flush and shall be free of voids. Mortar droppings shall be removed from brick ties and all other surfaces accepting air barrier.
- G. Sheathing boards shall be flush at joints, with gaps between boards according to building code and sheathing manufacturer's requirements. Sheathing boards shall also be securely fastened to the structure with proper fastener type, technique and spacing according to building code and sheathing manufacturer's requirements. Sheathing boards shall be repaired or replaced if inspection reveals moisture damage, mechanical damage or if sheathing boards have exceeded the exposure duration or exposure conditions as required by the sheathing manufacturer.
- H. Plywood, OSB, lumber or pressure-treated wood moisture content, measured with a wood moisture meter in the core of the substrate, shall be below 20%.

3.02 SURFACE PREPARATION

- A. Concrete masonry unit (CMU) wall shall be prepared as follows to accept the air & vapor barrier:
 - 1. Surfaces shall be free of contaminants such as grease, oil and wax on surfaces to receive membrane
 - 2. The CMU surfaces shall be free from projections.
 - 3. Strike all mortar joints flush to the face of the concrete block.
 - 4. Fill all voids and holes with mortar, sealant or other approved fill material.
 - 5. Surface irregularities shall be ground flush or made smooth.
 - 6. Fill around all penetrations with mortar, sealant or other approved fill material and strike flush.
 - 7. If the surfaces cannot be made smooth to the satisfaction of the Architect, it will be the responsibility of the trade to alternatively apply a parge coat (typically one part cement to three parts sand) over the entire surface to receive Air Barrier Membrane
 - 8. Remove mortar droppings on brick ties, shelf angles, brick shelves or other horizontal obstructions.
- B. Cover counter-sunk fasteners and holes through exterior sheathing with fill compound or detail sealant struck flush.

01-17-2022

- C. Fill cracks, gaps and joints with fill compound, detail sealant or other material approved by air barrier manufacturer.
- D. Fill rough gaps around pipe, conduit and similar penetrations with mortar, non-shrink grout, fill compound or polyurethane foam sealant shaved flush.
- E. Apply a 3/4-inch cant of fill compound or detail sealant at the intersection of the base of the wall and the footing.

3.03 DETAILING

- A. Detailing requires materials and installation at joints, transitions, openings, terminations, penetrations and similar conditions. Perform detailing before or after product installation.
- B. Install product and accessories in details as directed in manufacturer's literature.
- C. Cover sheathing joints with 2" width liquid detail flashing centered over joint:
- D. Sheathing inside and outside corners. Install flashing bearing 3 inches minimum onto either side of angle change. Use either of the following methods:
 - 1. Sheet detail flashing
 - 2. Liquid detail flashing
- E. Window rough openings. Install flashing bearing onto wall 3 inches minimum and returning into opening according to Project drawings. Use either of the following methods:
 - 1. Sheet detail flashing
 - 2. Liquid detail flashing
- F. Pipe or duct penetrations. Install flashing bearing onto wall 3 inches minimum and bearing onto pipe or duct 3 inches, or according to Project drawings. Use either of the following methods:
 - 1. Sheet detail flashing
 - 2. Liquid detail flashing
- G. Expansion or deflection joints: Install sheet detail flashing incorporating bellows or expansion bulb to allow joint movement. Flashing shall bear 3 inches minimum onto either side of joint.
- H. Interface of dissimilar substrates: Install sheet detail flashing, covering transition and bearing 3 inches minimum onto either side of transition.
- I. Prepare all surfaces accepting sheet detail flashing with contact adhesive provided by the same manufacturer. Apply contact adhesive to substrate with sufficient footprint to extend 1 inch beyond edges of sheet detail flashing. Follow contact adhesive application technique and drying time as specified in manufacturer's literature.
- J. Press sheet detail flashing firmly in place with a suitable hand roller tool.
- K. Sheet detail flashings shall be firmly adhered to the substrate, with no wrinkles, fishmouths or bridging at corners. Seal all terminations of sheet detail flashing with a tooled ribbon of detail sealant, centered over termination.
- L. Liquid detail flashings shall be smooth, free of voids and meeting the minimum installation thickness of 40 wet mils.

3.04 INSTALLATION

- A. Apply product and accessories over opaque wall surfaces as indicated in Project drawings.
- B. Apply product by roller, brush or other method as recommended by air barrier manufacturer.
- C. Apply product at specified wet mil thickness in accordance with air barrier manufacturer's requirements.
- D. Verify compliance with air barrier manufacturer's minimum required thickness by documenting product use per area. Perform and document wet mil thickness measurements every 100 square feet, or more frequently if required, to establish uniform and adequate coverage.
- E. Installation shall produce complete coverage of opaque substrates as indicated in Drawings.
- F. Product and accessories shall be fully-adhered to substrates, free of holes, fishmouths, blisters, de-lamination, bridging or inadequate mil thickness. Makes repairs to any of these defects

01-17-2022

according to air barrier manufacturer's instructions.

3.05 SCHEDULE WITH RELATED WORK

- A. Related Work shall be sequenced to allow effective installation and inspection of the air barrier.
- B. Finishes, insulation or other layers covering the air barrier shall not be installed until the air barrier installation over that area is complete, has been inspected and is approved to cover.
- C. If the air barrier has been damaged after installation, it shall be repaired according to air barrier manufacturer's instructions before covering.
- D. Penetrations made through the air barrier, such as mechanical/electrical penetrations and fasteners for attaching cladding/insulation, shall be sealed according to the air barrier manufacturer's instructions.
- E. Fenestration shall be sealed to air barrier with sheet detail flashing, silicone sheet, detail sealant, silicone sealant or polyurethane foam sealant according to Project drawings
- F. Through-wall flashing may be installed before or after air barrier. Seal termination of through-wall flashing to air barrier according product manufacturer's instructions.
- G. Wall air barrier shall have a durable, air and watertight seal to the foundation, below-grade waterproofing, roof air barrier, air barrier in neighboring wall assemblies and other conditions as indicated in Project drawings.

3.06 REPAIR AND PROTECTION

- A. Protect air barrier from damage during application and remainder of construction period.
- B. Inspect and make necessary repairs to air barrier before covering. Repair or replace damaged material according to manufacturer's literature.
- C. Air barrier is not designed for permanent exposure. Cover with insulation or exterior cladding as soon as schedule allows.
- D. Outdoor exposure of installed air barrier shall not exceed 180 days.

3.07 FIELD QUALITY CONTROL

- A. Testing Agency: Owner may engage a qualified testing agency to perform tests and inspections.
- B. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements.
- C. Air barriers will be considered defective if they do not pass tests and inspections.
 - 1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
 - 2. Remove and replace deficient air-barrier components for retesting as specified above.
- D. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

END OF SECTION 07 27 26

SECTION 07 54 23
TPO SINGLE-PLY ROOFING SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. TPO Thermoplastic Single-Ply Roofing System (Base Bid).

1.02 DESIGN CRITERIA

- A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
- B. The completed roof system shall meet the following requirements:
1. IBC 2015, Section 1609.
 2. ASCE 7, Chapters 26 to 30.
 3. External Fire Rating: UL Class A.
- C. Wind Load Design:
1. Risk Category: II.
 2. Basic Wind Speed (3-second gust): $V_{ult} = 115$ mph (51 m/s) per Figure 1609.3(1).
 - a. Wind speed conversion per Table 1609.3.1: $V_{asd} = 89$ mph (39 m/s)
 3. Surface Roughness Category (1609.4.2): B.
 4. Exposure Category (1609.4.3): C.
 5. ASTM D6630: Design uplift-resistance loads shall have a minimum 2.0 safety factor from the design wind uplift loads determined using ASCE 7.
- D. Wind Uplift Performance: Per IBC 2015, Section 1609.1, wind loads shall be determined in accordance with ASCE 7, Method 1 - Simplified Method. On this basis, the minimum design wind-resistance loads are as follows:
- E. Roof Covering External Fire Resistance Classification: Class A when tested per UL 790.
- F. Thermal Performance: Roof system will achieve a R-value of:
1. Sloped Roof Structure: R-30 (minimum). Refer to the structural drawings for slope provided by the roof framing system.
 2. Flat Roof Structure (No Slope) with tapered insulation: R-30 (Average).

1.03 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard 15-year NDL roof warranty, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.
1. Warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, roofing accessories, and other components of membrane roofing system.
 2. Wind Damage Coverage: Winds of 3-second peak gust speeds up to 72 mph, measured at 10-meters above ground using available meteorological data.
 3. Hail Damage Coverage: No.
 4. Puncture Coverage: No.
- B. Installer's Warranty: Submit roofing Installer's warranty covering Work of this Section, including all components of membrane roofing system such as membrane roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:
1. Warranty Period: Two (2) years from the Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Basis of Design Manufacturer: Subject to compliance with the Contract Documents, provide product/s from Carlisle SynTec.

- B. Other Manufacturers: The following manufacturers are approved to provide materials or products that are equivalent to the "Basis of Design":
 - 1. Firestone Building Products Company.
 - 2. GAF Materials Corporation.
 - 3. GenFlex Roofing Systems.
 - 4. Johns Manville.

2.02 SCOPE / APPLICATION

- A. Base Bid: TPO Membrane Roofing: One-Ply membrane, fully adhered, over cover board and insulation.
 - 1. Alternate No.1: Refer to Section 07 52 01.

2.03 ROOF INSULATION

- A. Polyisocyanurate Board Insulation: Rigid board with glass fiber reinforced facers (GRF) on both sides, meeting or exceeding the requirements of ASTM C1289, Type II, Class 1, fiber reinforced felt both faces; Grade 2 (20 psi).
 - 1. Basis of Design Product: Carlisle "InsulBase".
 - 2. Application Method: Mechanically Attached.
 - 3. R-Value: 5.7 per inch.
- B. Flat Panel Insulation:
 - 1. Insulation Thickness / R-Value: Provide multiple layer configuration of polyisocyanurate insulation to achieve a minimum R-value of [30], per the 2015 IECC, Table C402.1.3.
 - 2. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain.
 - a. Cricket shall slope 1/4-inch per foot unless otherwise indicated.
- C. Tapered Insulation:
 - 1. Panel Thickness: Panel thickness varies with taper/slope of the panel.
 - a. Provide factory-tapered insulation boards fabricated to slope 1/4-inch per foot towards roof drains. Cricket shall slope 1/4-inch per foot unless otherwise indicated.
 - 2. Insulation Thickness / R-Value: Provide tapered configuration of polyisocyanurate insulation to achieve an average R-value of 30, per the 2015 IECC, Table C402.1.3.
 - 3. Applications:
 - a. Flat roof areas where there is no slope in the roof framing.
 - b. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.04 COVER BOARD

- A. Water-resistant and silicone treated gypsum panel with embedded fiberglass facer on both sides, and pre-primed on one side. GP Gypsum Dens-Deck Prime, distributed by Carlisle.
 - 1. Board Thickness: 1/2 inch (13mm).

2.05 SINGLE-PLY ROOF MEMBRANE:

- A. Basis of Design Product:
 - 1. Carlisle "Sure-Weld" Adhered TPO Roofing System.
- B. Thickness: 60 mils (0.060 inch) (1.5 mm), minimum.
- C. Color: White.
- D. Attachment Method: Adhered.

2.06 FLASHING

- A. Flashing Membrane:
 - 1. Carlisle Sure-Weld TPO Flashing, 60-mils thick.

2.07 ROOF WALKWAYS

- A. Roof Walkways:
 - 1. Thickness: 180 mils.

2. Color: White.

PART 3 EXECUTION

3.01 INSULATION PLACEMENT

- A. Secure insulation to the substrate with the required mechanical fasteners in accordance with the manufacturer's current application guidelines.

3.02 COVER BOARD INSTALLATION

- A. Comply with membrane roofing system manufacturer's written instructions for installing roof cover board.

3.03 MEMBRANE PLACEMENT AND ATTACHMENT (SURE-WELD FULLY ADHERED)

- A. Apply approved Bonding Adhesive in accordance with the manufacturer's instructions.
- B. Hot-air weld the Sure-Weld membrane sheets in accordance with the manufacturer's hot air welding procedures.

3.04 FLASHING

- A. Follow manufacturer's typical flashing procedures for all wall, curb, and penetration flashing including metal edging/coping and roof drain applications.

3.05 WALKWAYS

- A. Install walkways at all traffic concentration points as identified on the Drawings.

END OF SECTION 07 54 23

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SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Fabricated sheet metal items, including flashings, counterflashings, gutters, and downspouts.
- B. Sealants for joints within sheet metal fabrications.
- C. Miscellaneous trim, flashing, closures and accessories.

1.03 RELATED SECTIONS

- Section 06 10 00 - Rough Carpentry.
- Section 07 72 00 - Roof Accessories.
- Section 07 92 00 - Joint Sealants.

1.04 REFERENCE STANDARDS

- A. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process 2021a.
- B. CDA A4050 - Copper in Architecture - Handbook current edition.
- C. SMACNA (ASMM) - Architectural Sheet Metal Manual 2012.

1.05 SUBMITTALS

- A. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
- B. Samples: Submit two samples 2 by 4 inch (____ by ____ mm) in size illustrating metal finish color.

1.06 QUALITY ASSURANCE

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

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- B. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Manufacturer: Products from Berridge Manufacturing Company are specified to establish a standard of quality for design, function, materials, and appearance.
- B. Other Manufacturers: The following manufacturers are approved to provide materials or products that are equivalent to the "Basis of Design":
 - 1. MBCI.
 - 2. AEP Span.
 - 3. CENTRIA Architectural Systems.
 - 4. Fabral.
 - 5. Petersen Aluminum Corporation .
 - 6. Tremco.
 - 7. Pac-Clad.
 - 8. Centria.
 - 9. ATAS International, Inc.

01-17-2022

10. Metl-Span.
11. or approved equal.

C. Substitutions: 01 25 00 - Substitution Procedures.

2.02 SHEET METAL MATERIAL

- A. Pre-Finished Galvanized Steel: Prefinished metal shall be 24-gauge Aluminum-zinc alloy-coated steel sheet, ASTM A792/A792M, with AZ50/AZM150 coating. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
1. Nominal Thickness: 0.024 inch (24-gauge).
 2. Surface: Smooth, flat finish.
 3. Exterior Finish: Two-coat fluoropolymer.
 4. Strippable film shall be applied to the top side of all prefinished metal to protect the finish during fabrication, shipping and field handling. This strippable film MUST be removed immediately before installation.

2.03 FINISH

- A. Paint Finish:
1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat applied by panel manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75 ± 0.05 mil (0.019 ± 0.0013 mm) over 0.2 ± 0.05 mil (0.05 ± 0.0013 mm) primer coat, to provide a total dry film thickness of 0.95 ± 0.10 mil (0.024 ± 0.0025 mm). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2.04 FABRICATION

- A. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- B. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- C. Form pieces in longest possible lengths.
- D. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.
- E. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- F. Fabricate corners from one piece with minimum 18 inch (450 mm) long legs; seam for rigidity, seal with sealant.
- G. Fabricate vertical faces with bottom edge formed outward 1/4 inch (6 mm) and hemmed to form drip.
- H. Fabricate flashings to allow toe to extend 2 inches (50 mm) over roofing . Return and brake edges.

2.05 GUTTER AND DOWNSPOUT FABRICATION

- A. Gutters: SMACNA (ASMM) Rectangular profile.
- B. Gutters and Downspouts: Size for rainfall intensity determined by a storm occurrence of 1 in 10 years in accordance with SMACNA (ASMM).
- C. Accessories: Profiled to suit gutters and downspouts.
1. Anchorage Devices: In accordance with SMACNA (ASMM) requirements.
- D. Splash Pads: Precast concrete type, of size and profiles indicated; minimum 3000 psi (21 MPa) at 28 days, with minimum 5 percent air entrainment.
- E. Downspout Boots: Steel.
- F. Downspout Extenders: Same material and finish as downspouts.

- G. Seal metal joints.

2.06 ACCESSORIES

A. Metal Components:

1. Provide accessories and other items essential to a complete roof or wall panel installation including panel clips, trim, closures, fascia, soffits, caps and similar metal components.
2. Metal components fabricated from same gauge and finish as metal panels, unless otherwise noted.
3. Flashing: Provide the same gauge and finish as the exterior panel, unless otherwise noted.

B. Sealants:

1. Exposed Sealants: One component silicone based as recommended by panel manufacturer; field applied.
2. Concealed Sealants: Non-curing, non-skinning butyl, polyisobutylene or polybutane tape as recommended by panel manufacturer; field applied.

C. Fasteners:

1. Exposed fasteners shall be hex head self-drilling screws with bonded washers and color to match panels. Screws may be either plated steel or stainless steel as noted on the Drawings.
2. Exposed stainless steel rivets shall match color finish of panel.

D. Primer: Zinc chromate type.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- A. Install starter and edge strips, and cleats before starting installation.
- B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil (0.4 mm).

3.03 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 3. Space cleats not more than 12 inches (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
 4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
 5. Install sealant tape where indicated.
 6. Torch cutting of sheet metal flashing and trim is not permitted.
 7. Retain subparagraph below if required to prevent galvanic corrosion between graphite and aluminum or aluminum-zinc alloy-coated steel. See the "Metal Considerations" Article in the Evaluations.
 8. Do not use graphite pencils to mark metal surfaces.

- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
 - 1. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
- D. Fastener Sizes: Use fasteners of sizes that will penetrate wood sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.
- E. Seal joints as shown and as required for watertight construction.
 - 1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
 - 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- F. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm), except reduce pre-tinning where pre-tinned surface would show in completed Work.
 - 1. Retain metals in first two subparagraphs below that are specified in Part 2; revise to suit Project. Soldering requires removal of painted, coated, or lacquered finishes. Although unusual, zinc-coated (galvanized) steel, a type of metallic-coated steel, may be soldered.
 - 2. Do not solder metallic-coated steel sheet.
 - 3. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.04 ROOF DRAINAGE SYSTEM INSTALLATION

- A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.

3.05 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
- B. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches (100 mm) over base flashing. Install stainless-steel draw band and tighten.
- C. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with butyl sealant and clamp flashing to pipes that penetrate roof.

3.06 MISCELLANEOUS FLASHING INSTALLATION

- A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.07 ERECTION TOLERANCES

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

3.08 CLEANING AND PROTECTION

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

END OF SECTION 07 62 00

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**SECTION 07 81 00
APPLIED FIREPROOFING**

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 SECTION INCLUDES

- A. Section includes sprayed fire-resistive materials (SFRM).

1.03 RELATED REQUIREMENTS

- A. Section 05 12 00 - Structural Steel Framing
- B. Section 05 21 00 - Steel Joist Framing
- C. Section 05 31 00 - Steel Decking
- D. Section 07 05 53 - Fire and Smoke Assembly Documentation
- E. Section 07 84 00 - Penetration Firestopping

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Framing plans, schedules, or both, indicating the following:
 - 1. Extent of fireproofing for each construction and fire-resistance rating.
 - 2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
 - 3. Minimum fireproofing thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
 - 4. Treatment of fireproofing after application.
- C. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard dimensions in size.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Product Certificates: For each type of fireproofing.
- C. Evaluation Reports: For fireproofing, from ICC-ES.
- D. Preconstruction Test Reports: For fireproofing.
- E. Field quality-control reports.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fireproofing manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.
- B. Mockups: Build mockups to set quality standards for materials and execution and for preconstruction testing.
 - 1. Build mockup of each type of fireproofing and different substrate as shown on Drawings.
 - 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.

01-17-2022

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

1.08 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Owner will engage a qualified testing agency to perform preconstruction testing on field mockups of fireproofing.
 1. Provide test specimens and assemblies representative of proposed materials and construction.
- B. Preconstruction Adhesion and Compatibility Testing: Test for compliance with requirements for specified performance and test methods.
 1. Bond Strength: Test for cohesive and adhesive strength according to ASTM E 736. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
 2. Density: Test for density according to ASTM E 605. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
 3. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with fireproofing.
 4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 5. For materials failing tests, obtain applied-fireproofing manufacturer's written instructions for corrective measures including the use of specially formulated bonding agents or primers.

1.09 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply fireproofing when ambient or substrate temperature is below 40 degrees F (4 degrees C) unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.
- B. Ventilation: Ventilate building spaces during and after application of fireproofing, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fireproofing dries thoroughly.

PART 2 PRODUCTS

2.01 MATERIALS, GENERAL

- A. Assemblies: Provide fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.
 1. Primary structural frame (i.e. columns, beams/girders connected to columns, braces), 3 Hours: UL X790.
 2. Floor beams & associated secondary members, 2 Hours: UL N759
 3. Roof construction & associated secondary members, 1 1/2 Hours: UL D756.
- B. Source Limitations: Obtain fireproofing for each fire-resistance design from single source.
- C. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E 119 or UL 263 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Steel members are to be considered unrestrained unless specifically noted otherwise.
- D. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction and the following VOC limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 1. Flat Paints and Coatings: 50 g/L.
 2. Nonflat Paints and Coatings: 150 g/L.
 3. Primers, Sealers, and Undercoaters: 200 g/L.
 4. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
- E. Asbestos: Provide products containing no detectable asbestos.

2.02 SPRAYED FIRE-RESISTIVE MATERIALS

- A. SFRM: Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application or conveyed in a dry state and mixed with atomized water at place of application.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Isolatek International; Cafco 300 or Cafco 400.
 - b. GCP Applied Technologies; MK-5
 2. Applications:
 - a. For Interior Applications; Concealed.
 - b. For Interior Applications; Exposed to View and Away from Damage.
 3. Bond Strength: Minimum 150-lbf/sq. ft. (7.18-kPa) cohesive and adhesive strength based on field testing according to ASTM E736.
 4. Density: Not less than 15 lb/cu. ft. as specified in the approved fire-resistance design, according to ASTM E605/E605M.
 5. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design or ASTM E605, whichever is thicker, but not less than 0.375-inches.
 6. Combustion Characteristics: ASTM E136
 7. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 10 or less.
 - b. Smoke-Developed Index: 10 or less.
 8. Compressive Strength: Minimum 10 lbf/sq. in. (68.9 kPa) according to ASTM E760/E760M.
 9. Corrosion Resistance: No evidence of corrosion according to ASTM E937/E937M.
 10. Deflection: No cracking, spalling, or delamination according to ASTM E759/E759M.
 11. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E760.
 12. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) in 24 hours according to ASTM E859/E859M.
 13. Fungal Resistance: No growth after 28 days when tested according to ASTM G21.
 14. Finish: Spray-textured finish.
 - a. Color: As indicated by manufacturer's designations.

2.03 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that are compatible with fireproofing and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
- B. Substrate Primers: Primers approved by fireproofing manufacturer and complying with one or both of the following requirements:
1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 2. Primer's bond strength in required fire-resistance design complies with specified bond strength for fireproofing and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E736.
- C. Bonding Agent: Product approved by fireproofing manufacturer and complying with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.
- D. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required, according to fire-resistance designs indicated and fireproofing manufacturer's written recommendations. Include clips, lathing accessories, corner beads, and other anchorage

01-17-2022

devices required to attach lath to substrates and to receive fireproofing.

1. Minimum weight of 1.7 psf (8 kg/sq m), galvanized finish.
- E. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by fireproofing manufacturer.
- F. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by fireproofing manufacturer. Include pins and attachment.
- G. Water: Clean, potable.
- H. Overcoat: As recommended by manufacturer of applied fireproofing material.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design. Verify compliance with the following:
 1. Substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fireproofing with substrates under conditions of normal use or fire exposure.
 2. Objects penetrating fireproofing, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
 3. Substrates receiving fireproofing are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fireproofing application.
- B. Verify that concrete work on steel deck has been completed before beginning fireproofing work.
- C. Verify that roof construction, installation of roof-top HVAC equipment, and other related work is complete before beginning fireproofing work.
- D. Conduct tests according to fireproofing manufacturer's written recommendations to verify that substrates are free of substances capable of interfering with bond.
- E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Cover other work subject to damage from fallout or overspray of fireproofing materials during application.
- B. Clean substrates of substances that could impair bond of fireproofing.
- C. Prime substrates where included in fire-resistance design and where recommended in writing by fireproofing manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fireproofing.
- D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fireproofing. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.03 APPLICATION

- A. Construct fireproofing assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fireproofing work.
- B. Comply with fireproofing manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fireproofing; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

01-17-2022

- C. Coordinate application of fireproofing with other construction to minimize need to cut or remove fireproofing.
 - 1. Do not begin applying fireproofing until clips, hangers, supports, sleeves, and other items penetrating fireproofing are in place.
 - 2. Defer installing ducts, piping, and other items that would interfere with applying fireproofing until application of fireproofing is completed.
- D. Metal Decks:
 - 1. Do not apply fireproofing to underside of metal deck substrates until concrete topping, if any, has been completed.
 - 2. Do not apply fireproofing to underside of metal roof deck until roofing has been completed; prohibit roof traffic during application and drying of fireproofing.
- E. Install auxiliary materials as required, as detailed, and according to fire-resistance design and fireproofing manufacturer's written recommendations for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by fireproofing manufacturer.
- F. Spray apply fireproofing to maximum extent possible. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by fireproofing manufacturer.
- G. Extend fireproofing in full thickness over entire area of each substrate to be protected.
- H. Install body of fireproofing in a single course unless otherwise recommended in writing by fireproofing manufacturer.
- I. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply fireproofing that differs in color from that of encapsulant over which it is applied.
- J. Where sealers are used, apply products that are tinted to differentiate them from fireproofing over which they are applied.
- K. Provide a uniform finish complying with description indicated for each type of fireproofing material and matching finish approved for required mockups.
- L. Cure fireproofing according to fireproofing manufacturer's written recommendations.
- M. Do not install enclosing or concealing construction until after fireproofing has been applied, inspected, and tested and corrections have been made to deficient applications.
- N. Finishes: Where indicated, apply fireproofing to produce the following finishes:
 - 1. Spray-Textured Finish: Finish left as spray applied with no further treatment.

3.04 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 - 1. Test and inspect as required by the applicable chapter of current adopted IBC.
- B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fireproofing for the next area until test results for previously completed applications of fireproofing show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.
- C. Fireproofing will be considered defective if it does not pass tests and inspections.
 - 1. Remove and replace fireproofing that does not pass tests and inspections, and retest.
 - 2. Apply additional fireproofing, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.
- D. Prepare test and inspection reports.

3.05 CLEANING, PROTECTING, AND REPAIRING

- A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

- B. Protect fireproofing, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fireproofing will be without damage or deterioration at time of Substantial Completion.
- C. As installation of other construction proceeds, inspect fireproofing and repair damaged areas and fireproofing removed due to work of other trades.
- D. Repair fireproofing damaged by other work before concealing it with other construction.
- E. Repair fireproofing by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

END OF SECTION 07 81 00

**SECTION 07 84 00
PENETRATION FIRESTOPPING**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Penetrations in fire-resistance-rated walls.
- B. Penetrations in horizontal assemblies.
- C. Penetrations in smoke barriers.

1.03 RELATED SECTIONS

Section 07 92 00 - Joint Sealants

1.04 ACTION SUBMITTALS

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

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
 - 1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
 - b. Classification markings on penetration firestopping correspond to designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek ETL SEMKO in its "Directory of Listed Building Products."
 - 3) FM Global in its "Building Materials Approval Guide."

1.07 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when

01-17-2022

substrates are wet because of rain, frost, condensation, or other causes.

- B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.08 COORDINATION

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, available products that may be incorporated into the Work include, but are not limited to, the following manufacturers:
 - 1. Specified Technologies Inc.
 - 2. Hilti, Inc.
 - 3. 3M Fire Protection Products.
- B. Substitutions: Section 01 25 00 - Substitution Procedures.

2.02 PENETRATION FIRESTOPPING

- A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
 - 1. Fire-resistance-rated walls include fire-barrier walls and smoke-barrier walls.
 - 2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
 - 1. Horizontal assemblies include floors and floor/ceiling assemblies.
 - 2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
 - 3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
- D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.
 - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at 0.30-inch wg (74.7 Pa) at both ambient and elevated temperatures.
- E. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.
- F. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.
- G. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.

01-17-2022

- H. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
 - 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-wool-fiber or rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
 - 2. Temporary forming materials.
 - 3. Substrate primers.
 - 4. Collars.
 - 5. Steel sleeves.

2.03 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multi-component, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and non-sag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of non-sag grade for both opening conditions.

2.04 MIXING

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

2.05 MATERIALS

- A. General: Use only through-penetration firestop system products that have been tested for specific fire-resistance-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.
- B. Latex Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture, the following products are acceptable:
 - 1. Specified Technologies, Inc. (STI) SpecSeal Series SSS Intumescent Sealant
 - 2. Specified Technologies, Inc. (STI) SpecSeal Series LCI Intumescent Sealant
 - 3. Specified Technologies, Inc. (STI) SpecSeal Series LC Endothermic Sealant
 - 4. Specified Technologies, Inc. (STI) SpecSeal Series AS Elastomeric Spray
 - 5. Products equal to above as manufactured by Hilti or 3M Fire Protection Products.
- C. Firestop Devices: Factory-assembled steel collars lined with intumescent material sized to fit specific outside diameter of penetrating item, the following products are acceptable:
 - 1. Specified Technologies, Inc. (STI) SpecSeal Series SSC Firestop Collars
 - 2. Specified Technologies, Inc. (STI) SpecSeal Series LCC Firestop Collars
 - 3. Products equal to above as manufactured by Hilti or 3M Fire Protection Products.
- D. Wall Opening Protective Materials: Intumescent, non-curing pads or inserts for protection of electrical switch and receptacle boxes to reduce horizontal separation to less than 24", the following products are acceptable:
 - 1. Specified Technologies, Inc. (STI) SpecSeal Series SSP Firestop Putty Pads
 - 2. Specified Technologies, Inc. (STI) SpecSeal Series EP PowerShield Insert Pads
 - 3. Products equal to above as manufactured by Hilti or 3M Fire Protection Products.
- E. Firestop Putty: Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds, the following products are acceptable:
 - 1. Specified Technologies, Inc. (STI) SpecSeal Series SSP Firestop Putty
- F. Wrap Strips: Single component intumescent elastomeric strips faced on both sides with a plastic film, the following products are acceptable:
 - 1. Specified Technologies, Inc. (STI) SpecSeal Series RED Wrap Strip
 - 2. Specified Technologies, Inc. (STI) SpecSeal Series BLU Wrap Strip
 - 3. Products equal to above as manufactured by Hilti or 3M Fire Protection Products.
- G. Firestop Pillows: Re-enterable, non-curing, mineral fiber core encapsulated with an intumescent coating contained in a flame retardant poly bag, the following products are acceptable:
 - 1. Specified Technologies, Inc. (STI) SpecSeal Series SSB Firestop Pillows
 - 2. Products equal to above as manufactured by Hilti or 3M Fire Protection Products.
- H. Mortar: Portland cement based dry-mix product formulated for mixing with water at Project site to form a non-shrinking, water-resistant, homogenous mortar, the following products are acceptable:
 - 1. Specified Technologies, Inc. (STI) SpecSeal Series SSM Firestop Mortar
 - 2. Products equal to above as manufactured by Hilti or 3M Fire Protection Products.
- I. Silicone Sealants: Moisture curing, single component, silicone elastomeric sealant for horizontal surfaces (pourable or nonsag) or vertical surface (nonsag), the following products are acceptable:
 - 1. Specified Technologies, Inc. (STI) Pensil 300 Silicone Sealant
 - 2. Specified Technologies, Inc. (STI) Pensil 300 SL Self-Leveling Silicone Sealant
 - 3. Products equal to above as manufactured by Hilti or 3M Fire Protection Products.
- J. Silicone Foam: Multicomponent, silicone-based liquid elastomers, that when mixed, expand and cure in place to produce a flexible, non-shrinking foam, the following products are acceptable:
 - 1. Specified Technologies, Inc. (STI) Pensil 200 Silicone Foam
 - 2. Products equal to above as manufactured by Hilti or 3M Fire Protection Products.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.03 INSTALLATION

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

3.04 IDENTIFICATION

- A. Identify penetration firestopping with preprinted bar-coded, metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing and inspecting agency with penetration test number.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.

- B. Identify all fire walls, fire barriers, fire partitions smoke barriers and smoke partitions or any other wall required to have protected openings or penetrations with permanent signs or stenciling. Such identification shall:
 - 1. Be located in accessible concealed floor, floor-ceiling or attic spaces;
 - 2. Be located 15 feet (4.572 m) of the end of each wall and at intervals not exceeding 30 feet (9.144 m) measured horizontally along the wall or partition; and
 - 3. Include lettering not less than 3 inches (76 mm) in height with minimum 3/8 inch (9.5 mm) stroke in a contrasting color incorporating the type of wall and/or partition followed by the phrase, "-PROTECT ALL OPENINGS."

3.05 CLEANING AND PROTECTION

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

END OF SECTION 07 84 00

**SECTION 07 92 00
JOINT SEALANTS**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Silicone joint sealants.
- B. Urethane joint sealants.
- C. Polyurea joint sealants.
- D. Latex joint sealants.
- E. Acoustical joint sealants.
- F. Security (tamper-resistant) joint sealants.

1.03 RELATED SECTIONS

Section 03 30 00 - Cast-in-Place Concrete
Section 04 20 00 - Unit Masonry
Section 06 61 16 - Solid Surface Fabrication
Section 09 21 16 - Gypsum Board Assemblies
Section 09 30 00 - Tiling

Divisions 21, 22, 23, 26, 27 specifications regarding building service systems that penetrate walls, floors, and ceilings.

Seal interior penetration openings in a manner that prevents transmission of airborne noise and structural vibration into acoustically sensitive/critical spaces. Penetrations shall include conduit, duct, pipe, cable, recessed boxes, and other penetrants, assemblies, or devices noted in the Documents.

1.04 REFERENCE STANDARDS:

- A. ASTM C510 - Standard Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealant, 1990.
- B. ASTM C639 - Test Method for Rheological (Flow) Properties of Elastomeric Sealants, 1990.
- C. ASTM C719 - Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement, 1993.
- D. ASTM C834 - Standard Specification for Latex Sealants.
- E. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications.
- F. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
- G. ASTM C1021 - Standard Practice for Laboratories Engaged in Testing of Building Sealants.
- H. ASTM C1193 - Standard Guide for Use of Joint Sealants.
- I. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants.
- J. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
- K. ASTM D412. Test Method for Vulcanized Rubber and Thermo-Plastic Rubbers and Thermo-Plastic Elastomers/Tensions.
- L. ASTM D2240. Test Method for Rubber Property- Durometer Hardness.
- M. ASTM E90 -

01-17-2022

- N. American Association of State Highway and Transportation Officials (AASHTO), Standard Specifications for Highway Bridges, Thirteenth Edition, 1992. See Table 25.2B for physical property requirements of bridge bearing quality neoprene.

1.05 ACTION SUBMITTALS

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

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and testing agency.
- B. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
- D. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- E. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- F. Field-Adhesion Test Reports: For each sealant application tested.
- G. Warranties: Sample of special warranties.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.
- C. Product Testing: Test joint sealants using a qualified testing agency.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.
 - 2. Test according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.
- D. Preinstallation Conference: Conduct conference at Project site.

1.08 PROJECT CONDITIONS

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

01-17-2022

1.09 WARRANTY

- A. Installation Warranty: The Installer shall warrant the products to be free of defects in material and workmanship for a period of two (2) years from Date of Substantial Completion.
- B. Manufacturer Warranty: The Manufacturer shall warrant the products against material defects, or defects in manufacturing, for a period of five (5) years from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Specified Manufacturer: Multiple manufacturer's specified.
 - 1. Products of the manufacturer's listed below will be accepted. Additional manufacturers will be considered in accordance with the "or equal" provision specified in Section 01 60 00 - Product Requirements.
 - a. Dow Corning Corporation.
 - b. GE Advanced Materials.
 - c. Tremco Incorporated.
 - d. Pecora Corporation.
 - e. BASF Building Systems.
 - f. Surebond.
 - g. GE Advanced Materials.
 - h. Sika Flex.
- B. Substitutions: Submit a request for substitution for any manufacturer not named, as specified in Section 01 25 00 - Substitution Procedures.
- C. Substitutions: 01 25 00 - Substitution Procedures.

2.02 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Basis-of-Design Manufacturer/Products: Subject to compliance with the Contract Documents, available products that may be incorporated into the Work include, but are not limited to, the following manufacturers: Architectural Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.
- C. Liquid-Applied Joint Sealants: Comply with ASTM C920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C1248 and have not stained porous joint substrates indicated for Project.
- E. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- F. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.03 SILICONE JOINT SEALANTS

- A. Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C920 , Type S, Grade NS, Class 25, for Use NT.
 - 1. Basis-of-Design Manufacturer/Product:
 - a. Dow Corning Corporation; 995 Silicone Structural Sealant.
 - b. GE Advanced Materials - Silicones; Sanitary SCS1700.
 - c. Tremco Incorporated; Tremsil 200 Sanitary.

- d. Pecora Corporation; Pecora 898 NST
- B. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C920, Type S, Grade NS, Class 50, for Use NT.
 - 1. Basis-of-Design Manufacturer/Products:
 - a. BASF Building Systems; MasterSeal NP 1.
 - b. Dow Corning Corporation; 795.
 - c. GE Advanced Materials ; SilPruf.
 - d. Pecora Corporation; Pecora 890 NST, 890FTS (Field Tintable).
 - e. Tremco Incorporated; Spectrem 3.

2.04 URETHANE JOINT SEALANTS

- A. Multi-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C920, Type M, Grade P, Class 25, for Use T.
 - 1. Basis-of-Design Manufacturer/Products:
 - a. BASF Building Systems; MasterSeal SL 2.
 - b. Pecora Corporation; Dynatrol II.
 - c. Tremco Incorporated; Vulkem 245.
 - d. SikaFlex 2c SL
 - e. Sherwin Williams Loxon 2K SL
- B. Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C920, Type M, Grade NS, Class 50, for Use NT.
 - 1. Basis-of-Design Manufacturer/Products:
 - a. BASF Building Systems; MasterSeal NP 2.
 - b. Pecora Corporation; Dynaflex.
 - c. Tremco Incorporated; Dymeric 240.
 - d. SikaFlex 2c NC
 - e. Sherwin Williams Loxon 2K NS

2.05 POLYUREA SEALANTS

- A. Semi-Rigid, Multi-Component Polyurea Sealant: Self-leveling, 100% solids, rapid curing, polyurea control joint and crack filler with a Shore D 85 or higher hardness when tested in accordance with ASTM D2240. Tensile strength of 1160 pounds per square inch when tested in accordance with ASTM D412.
 - 1. Basis-of-Design Manufacturer/Products:
 - a. VersaFlex Incorporated; S/L 85.
 - b. L & M Construction Chemicals, Inc.; Joint Tite 750.

2.06 LATEX JOINT SEALANTS

- A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
 - 1. Basis-of-Design Manufacturer/Products:
 - a. Pecora Corporation; AC-20+.
 - b. Tremco Incorporated; Tremflex 834.

2.07 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Joint Sealant: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90.
- B. Properties: Acoustical sealants shall have the following properties:
 - 1. Hardness of no more than 50 durometer Shore A as rated in ASTM D2240.
 - 2. Minimum elongation of 500% as rated in ASTM D412.
 - 3. Minimum joint width movement of 25% as rated in ASTM C719.
 - 4. Self Leveling type (S/L) if applied on floors in accordance with ASTM C639.
 - 5. Non-Sag type (N/S) if applied on walls in accordance with ASTM C639.

01-17-2022

6. Acoustical sealants must meet the following additional requirements where applied in exposed locations:
 - a. Acoustical sealants shall be paintable.
 - b. Acoustical sealants shall be skinning type.
 - c. Acoustical sealants shall be non-staining type as rated in ASTM C510.
- C. For concealed locations, acoustical sealants shall be one of the following approved products. Substitutions are unacceptable unless otherwise approved by the Architect and project Acoustics Consultant.
 1. Acoustic Surfaces, AS-29
 2. GE SilPruf SCS2000
 3. PTI Architectural Sealant 707
- D. For exposed locations, acoustical sealants shall be one of the following approved products. Substitutions are unacceptable unless otherwise approved by the Architect and project Acoustics Consultant.
 1. DAP Dynaflex 2
 2. GE SCS7000
 3. Sikaflex 1a
- E. For fire-rated locations, acoustical sealants shall be one of the following approved products. Substitutions are unacceptable unless otherwise approved by the Architect and project Acoustics Consultant.
 1. HILTI CP 601S
 2. STI Spec Seal PEN300
 3. Tremco Fyre-Sil
 4. Johns Manville Firetemp CI

2.08 PUTTY PADS

- A. Putty pads shall be made from polybutene-butyl with inert fillers or other approved permanently resilient self-adhering material.
- B. Putty pads shall have a minimum thickness of 1/8-inch.
- C. For non-rated locations, putty pads shall be the following approved product. Substitutions are unacceptable unless otherwise approved by the Architect and project Acoustics Consultant.
 1. Harry A. Lowry & Associates Outlet Box Pads
- D. Basis-of-Design Manufacturer/Products:
 1. Hevi-Duty Nelson FSP Putty Pads
 2. STI Spec Seal SSP Putty Pads
 3. 3M Fire Barrier Putty Pads
 4. Substitutions are unacceptable unless otherwise approved by the Architect and project Acoustics Consultant.

2.09 PACKING MATERIAL

- A. Packing material shall be of the following types:
 1. Mineral Fiber
 2. Glass Fiber
 3. Preformed Pipe Insulation
 4. Others as approved by the acoustical sealant manufacturer and project Acoustics Consultant.

2.10 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C1330, Type B (bicellular 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.

2.11 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of^{f**} sealant to joint substrates indicated.
- 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: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 EXTENT

- A. Resiliently seal all penetrations (conduit, ducts, pipes, cables, recessed boxes, etc.) using acoustical sealant and/or putty pads through all walls, floors, and ceilings of the following spaces:
 - 1. As noted on the Penetration Control drawings.
 - 2. Mechanical, electrical, and elevator equipment rooms.
 - 3. Rooms containing motorized theatrical equipment, sound racks, dimmer racks, or any other equipment that contains a transformer, fan, or motor.
- B. At double-wall or triple-wall partitions, resiliently seal penetrations at each wall.
- C. If the Contract Documents seem unclear, request clarification of extent from the Architect.

3.03 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. Unglazed surfaces of ceramic tile.
 - 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 glass 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.

3.04 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 Non-sag 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.
 - 4. Provide flush joint profile where indicated per Figure 8B in ASTM C1193.
 - 5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.
- G. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written recommendations.

3.05 ACOUSTICAL SEALANTS

- A. Opening Requirements
 - 1. In metal stud assemblies, each penetrant must be housed in an individual opening properly sized for that penetrant. Routing multiple penetrants through a single opening is not allowed. The following requirements apply:
 - a. Provide a minimum of 2x wood blocking or 2 layers of 3/4" plywood spanning between studs for pipe, conduit, cable, and round duct penetrants to form the

01-17-2022

- opening without the use of a sheetmetal sleeve.
- b. Frame openings for rectangular duct penetrants without the use of a sheetmetal sleeve.
- c. The space between the opening and the penetrant shall be 1/2-inch minimum to 3/4-inch maximum around the penetrant. The penetrant shall be centered within the opening to prevent contact between the opening and the penetrant.
- 2. In masonry or precast concrete assemblies, each penetrant must be housed in an individual opening properly sized for that penetrant. Routing multiple penetrants through a single opening is not allowed. The following requirements apply:
 - a. At masonry assemblies, properly form openings to minimize the grout needed between the opening and the sleeve.
 - b. Provide sleeves that are grouted in place. Sleeve ends shall be flush with surrounding substrates. Provide infill around all sleeves with material of surface weight equal to or greater than the surrounding substrate. All void spaces between sleeve and masonry or precast concrete must be filled airtight.
 - c. In grout-filled masonry or precast concrete, properly sized core drilled holes may be used in lieu of sleeves.
 - d. The space between the sleeve and the penetrant shall be 1/2-inch minimum to 3/4-inch maximum around the penetrant. The penetrant shall be centered within the opening to prevent contact between the sleeve and the penetrant.
 - e. At multi-wythe partitions, provide separate sleeves at each wythe. Sleeves may not bridge airspace(s) of multi-wythe partitions.
- 3. In poured concrete assemblies, penetrants can be housed in an individual opening properly sized for that penetrant or housed in an opening properly sized for several penetrants. When multiple penetrants are housed in a single opening, the following requirements apply:
 - a. Each penetrant must be sleeved.
 - b. Sleeve ends shall be flush with surrounding substrates. Provide infill around all sleeves with material of surface weight equal to or greater than the surrounding substrate. All void spaces between sleeves and concrete must be filled airtight.
 - c. The space between the sleeve and the penetrant shall be 1/2-inch minimum to 3/4-inch maximum around the penetrant. The penetrant shall be centered within the opening to prevent contact between the sleeve and the penetrant.
 - d. At multi-wythe partitions, provide separate sleeves at each wythe. Sleeves may not bridge airspace(s) of multi-wythe partitions.
- B. Clearances
 - 1. Maintain a 4-inch minimum clear space around duct penetrations so that an airtight seal can be easily installed without conflicts from nearby penetrants, floors, ceilings, walls, or other obstructions.
 - 2. Maintain a 2-inch minimum clear space around all other penetrations so that an airtight seal can be easily installed without conflicts from nearby penetrants, floors, ceilings, walls, or other obstructions.
- C. Sealing
 - 1. Do not proceed with installation if opening requirements or other requirements specified herein are not met. Conditions shall be corrected to meet the requirements of this Specification before sealant is installed.
 - 2. Prepare and install backer rod material in accordance with manufacturer's recommendations for proper application of sealant.
 - 3. Loosely fill space between opening or sleeve and penetrant with clean packing material to be nearly flush with both ends of opening or sleeve.
 - 4. Seal both ends of penetration with liberal bead of sealant applied continuously around the penetration and jointed end-to-end to form an airtight, continuous membrane.
 - a. Sealant shall completely fill the space surrounding the penetrant.
 - b. Sealant thickness shall be as recommended by the manufacturer, no less than 1/4-inch.

5. When complete, sealant shall be flush with surrounding substrate.

3.06 PUTTY PADS

- A. Brush or wipe construction dust and dirt from recessed box.
 1. If surface is contaminated with oil, wipe with xylene or toluene to remove oily residue.
- B. Before mounting recessed box or attaching conduit, adhere putty pad to box back and mounting side(s). Leave 1/2-inch minimum overlap along the front surface to enable wrapping of plaster ring.
- C. Mount recessed box and install plaster ring. Tighten all loose fasteners.
- D. Continue wrapping recessed box, all conduit attachments and plaster ring with putty pad. Press putty pad firmly into surfaces.
 1. If necessary, cut and apply additional pieces of putty pad to achieve an airtight seal around the recessed box, conduit attachments, and plaster ring.
- E. After gypsum board installation, press putty pad firmly against gypsum board to create an airtight seal.
 1. If airtight seal is not continuous around the plaster ring perimeter, seal any gaps or voids with a liberal bead of acoustical sealant to create an airtight seal.

3.07 PUTTY

- A. Brush or wipe construction dust and dirt from cables and conduit.
 1. If surfaces are contaminated with oil, wipe with xylene or toluene to remove oily residue.
- B. Properly space cables away from each other inside the conduit.
- C. Tightly pack mineral fiber between all cables.
 1. Pack mineral fiber tight around cables the full depth of the sleeve, holding back the mineral fiber 1/4" from both ends of the conduit sleeve.
- D. Fill all spaces between the cables and conduit with putty to a 1/4" depth to create an airtight seal. The putty shall be flush with both ends of the conduit sleeve or conduit stub.

3.08 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 1. Extent of Testing: Test completed and cured sealant joints as follows:
 - a. Perform 10 tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.
 - b. Perform 1 test for each 1000 feet (300 m) of joint length thereafter.
 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 3. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

- B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.09 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.

3.10 PROTECTION

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

3.11 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
 - 1. Joint Locations:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.
 - 2. Urethane Joint Sealant: Multi component, pourable, traffic grade, Class 25.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
 - 1. Joint Locations:
 - a. Construction joints in cast-in-place concrete.
 - b. Joints in exterior insulation and finish systems.
 - c. Joints between metal panels.
 - d. Joints between different materials listed above.
 - e. Perimeter joints between materials listed above and frames of doors, windows and louvers.
 - f. Control and expansion joints in ceilings and other overhead surfaces.
 - g. Other joints as indicated.
 - 2. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 50.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces, except control joints scheduled to receive floor coverings, resinous flooring or polished concrete finish.
 - 1. Joint Locations:
 - a. Isolation joints in cast-in-place concrete slabs.
 - 2. Urethane Joint Sealant: Multi component, pourable, traffic grade, class 25.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Joint-Sealant Application: Interior joints in horizontal traffic surfaces at tile flooring.
 - 1. Joint Locations:
 - a. Expansion joints in tile flooring.
 - 2. Urethane Joint Sealant: Multi component, pourable, traffic grade, class 25.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Joint-Sealant Application: Interior control/contraction joints in horizontal traffic surfaces.
 - 1. Joint Locations:
 - a. Control/contraction joints in dyed and polished concrete slabs.
 - 2. Polyurea Joint Sealant: Multicomponent, self-leveling, traffic grade.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- F. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.

01-17-2022

1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Vertical joints on exposed surfaces of interior unit masonry and concrete.
 2. Urethane Joint Sealant: Multi component, nonsag, Class 50.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- G. Joint-Sealant Application: Interior non-moving joints in vertical surfaces.
1. Joint Locations:
 - a. Vertical joints in exposed surfaces of gypsum drywall partitions.
 - b. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
 - c. Other joints as indicated.
 2. Acrylic Latex Joint Sealant: Paintable
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- H. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Sealant Location:
 - a. Joints between plumbing fixtures and adjoining walls, floors, counters.
 - b. Joints between backsplashes and adjacent wall surfaces at wet locations.
 - c. Tile control and expansion joints where indicated.
 - d. Other joints at wet locations where or not specifically detailed or called out to seal joints from leakage of water.
 2. Silicone Joint Sealant: Single component, nonsag, mildew resistant, acid curing, Class 25.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- I. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Location:
 - a. Provide acoustical joint sealant at all wall locations where sound attenuation batts are shown in the wall types.
 - b. Apply putty pads to all recessed boxes sharing a stud space where separate recessed boxes are open to both sides of wall.
 - c. Other joints as indicated.
 2. Joint Sealant: Acoustical.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- J. Security Joint-Sealant Application: Interior non-moving joints in horizontal and vertical surfaces.
1. Joint Locations:
 - a. Change in plane expansion and contraction joints: Floor-to-wall, head of wall, and inside corners;
 - b. Fixture Perimeters: Lights, mirrors, sinks, etc.
 - c. Door and Window Perimeters: Frame to wall, gypsum, concrete block.
 - d. Interior Seams: Steel, stainless steel, masonry, window frames, and fixtures
 - e. Protrusions and Penetrations;
 - f. Resilient Base: Perimeter joints to the wall and floor, and vertical joints between base pieces.
 - g. Other joints as indicated.
 2. Polyurethane Joint Sealant:
 - a. Single-component, tamper-resistant, non-sag, STPU;

END OF SECTION 07 92 00

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SECTION 07 95 13
EXPANSION JOINT COVER ASSEMBLIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Interior expansion control systems.
- B. Exterior expansion control systems.
- C. Expansion Joint accessories including provisions for fire rated assemblies, moisture barriers, waterproofing, acoustic measures, or thermal measures.

1.03 RELATED SECTIONS

- A. Section 07 52 01 - APP Modified Bituminous Membrane Roofing
- B. Section 07 62 00 - Sheet Metal Flashing and Trim: Roof expansion and control joint covers.

1.04 REFERENCE STANDARDS

- A. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
- B. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.
- C. ASTM B308/B308M - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles 2020.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures.
- B. Product Data: Provide joint assembly profiles, profile dimensions, anchorage devices and available colors and finish.
- C. Shop Drawings: Indicate joint and splice locations, miters, layout of the work, affected adjacent construction and anchorage locations.
- D. Samples: Submit two samples 6 inch (152 mm) long, illustrating profile, dimension, color, and finish selected.
- E. Manufacturer's Installation Instructions: Indicate rough-in sizes and required tolerances for item placement.

1.06 SYSTEM DESCRIPTION

- A. Joint coverplate systems shall permit daily thermal expansion and contraction of building elements, minor foundation settlement, and common windsway movements of the structure without disengagement.
 - 1. Joint system details shall clearly indicate X-axis joint movement capabilities (horizontal contraction/ expansion). Y-axis joint movement (in-plane shear), and Z-axis movement (vertical shear) may be requested of the Manufacturer if applicable.
 - 2. Movement capabilities shall be clearly defined as a percentage of the nominal joint width or with distinct dimensions defined on product details.
- B. Joint Systems shall allow for seismic movement (if applicable), matching requirements as defined within the Project Specific Structural Specifications.
- C. Fire Rated Assemblies shall be tested by registered Third Party Testing Agencies in accordance with UL2079, ULC S115, or BS 476 classified systems. Expansion joint assembly fire rating shall match or exceed the fire rating of adjacent construction.

01-17-2022

1.07 QUALITY ASSURANCE

- A. Manufacturer: Furnish assemblies from one (1) manufacturer with a minimum of five (5) years of experience in the design, engineering and fabrication of expansion joint systems.
- B. Installer: Firm with not less than three (3) years of successful experience in the installation of systems similar to those required by this project and acceptable to the manufacturer of the system.

1.08 DELIVERY AND STORAGE

- A. Manufacturer to provide protective film on all exposed cover plate components.
- B. Deliver joint systems to jobsite in new, clean, unopened cartons or crates of sufficient size and strength to protect materials during transit.
- C. Inspect materials upon arrival. Store components in original containers in a clean, dry location. Ensure temperature or moisture sensitive components are stored in a tempered location.
- D. Contractor to provide temporary protective covers on all installed finished surfaces. Protection is required to guard against both surface abrasions as well as overloading of horizontal deck components by construction traffic.

1.09 SEQUENCING

- A. Submittals shall be completed and remitted to the Project Architect within 4 weeks after award of subcontract.
- B. Subcontract for the work of this section shall be planned to allow sufficient time for Manufacturer's production and delivery scheduling.

1.10 WARRANTY

- A. Manufacturers limited warranty against material and manufacturing defects for a period of not less than five (5) years from Date of Substantial Completion, when installed in accordance with manufacturer's recommendations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Specified Manufacturer: Joint Master, a Division of InPro Corporation (P: (800) 222-5556 / Web: www.inprocorp.com)
- B. Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be accepted. Additional manufacturers will be considered in accordance with the "or equal" provision specified in Section 01 60 00 - Product Requirements.
 - 1. Architectural Art Mfg, Inc .
 - 2. Construction Specialties, Inc .
 - 3. MM Systems Corp .
 - 4. Nystrom, Inc.
- C. Substitutions: Submit a request for substitution for any manufacturer not named, as specified in Section 01 25 00 - Substitution Procedures.

2.02 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper; or ASTM B308/B308M, 6061 alloy, T6 temper.
 - 1. Exposed Finish Outdoors: Natural anodized.
 - 2. Exposed Finish at Floors: Mill finish or natural anodized.
 - 3. Exposed Finish at Walls and Ceilings: Natural anodized.
- B. Stainless Steel: Alloy Type 304 for plates and strips.
 - 1. Brushed #4 surface finish standard
- C. Elastomeric Seals: Synthetic rubber seals comprised of a dual extrusion Santoprene rubber for heat welding of all transitions and seams for a monolithic, weathertight installation. EPDM and Neoprene substitutions are not allowed due to their lack of ability to meet this specific

01-17-2022

requirement.

1. All Santoprene seals must be certified as low VOC as certified by UL Environmental GreenGuard Gold Certification
- D. Horizontal and Vertical Moisture Barrier (optional accessory): Min. 45 mil thick fabric reinforced EPDM with optional watertight drain assemblies.
- E. Horizontal and Vertical Insulated Vapor Barrier (optional accessory):
 1. Min. R Value of 15
 2. Must meet ASTM E1399 Cyclic movement requirements matching movement requirements specific to project.

2.03 INTERIOR WALL AND CEILING JOINT SYSTEMS

- A. Glide Plate Expansion Joint Systems
- B. Expansion Joint System, Type EJ-1:
 1. Product: JointMaster, Model No. 300-A07-100.
 2. Type: Glide Plate Expansion Joint System.
 3. Application: Wall-to-Wall and Ceiling-to-Ceiling Conditions.
 4. Joint Size: 4-inches.
 5. Movement:
 - a. Horizontal: 2-inches.
 - b. Vertical: 1-inch.
 6. Finish: Clear anodized.
- C. Expansion Joint System, Type EJ-2:
 1. Product: JointMaster, Model No. 300-A09-100.
 2. Type: Glide Plate Expansion Joint System.
 3. Application: Wall-to-Corner and Wall-to-Ceiling Conditions.
 4. Joint Size: 4-inches.
 5. Movement:
 - a. Horizontal: 2-inches.
 - b. Vertical: 1-inch.
 6. Finish: Clear anodized.

2.04 EXTERIOR VERTICAL WALL JOINT SYSTEMS

- A. Vertical Open Cell Silicone Faced Water-resistant Foam:
- B. Expansion Joint System, Type EJ-3:
 1. Product: JointMasters, Model No. 1200-200.
 2. Type: Pre-compressed open micro-cell polyurethane foam impregnated with a polymer sealing compound.
 3. Application: Wall-to-Wall and Wall-to-Corner conditions.
 4. Foam joint sealant is field compressed and is non-drying, non-shrinking, self-healing, and self-expanding.
 5. Exposed surface(s) is silicone coated with single, double, or triple faced configurations available.
 6. Color/s: To be selected from manufacturers standard colors.
 7. Joint Width: 2-inches.
 8. Joint Operating Range: 50%+- of total nominal joint width.
 9. Orientation: Vertical.

2.05 EXTERIOR ROOF JOINT SYSTEMS

- A. Expansion Joint System, Type EJ-4:
 1. Type: Metal Coverplate Roof Expansion Joint System.
 2. Product: JointMasters, Model No. 661-A02-050.
 3. Application: Roof-to-Wall condition.
 4. Joint Width: 2-inches (51 mm).
 5. Frame Height: 1-1/4 inches (32 mm)

6. Sightline: 3-5/8 inch (92 mm)
 7. Movement:
 - a. Horizontal: 1-inch
 - b. Vertical: 1-inch
 8. Finish: Clear anodized aluminum.
 9. Installation: Curb-Mounted.
- B. Expansion Joint System, Type EJ-5:
1. Type: Metal Coverplate Roof Expansion Joint System.
 2. Product: JointMasters, Model No. 661-A02-100.
 3. Application: Roof-to-Wall condition.
 4. Joint Width: 4-inches (102 mm).
 5. Frame Height: 1-1/4 inches (32 mm)
 6. Sightline: 6-1/2 inch (165 mm)
 7. Movement:
 - a. Horizontal: 2-inches
 - b. Vertical: 2-inches
 8. Finish: Clear anodized aluminum.
 9. Installation: Curb-Mounted.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that joint preparation and dimensions are acceptable and in accordance with manufacturer's requirements.
- B. Verify that frames and anchors installed by others are in correct locations and suitable for installation of remainder of assembly.

3.02 INSTALLATION

- A. Install components and accessories in accordance with manufacturer's instructions.
- B. Align work plumb and level, flush with adjacent surfaces.
- C. Rigidly anchor to substrate to prevent misalignment.

3.03 PROTECTION

- A. Do not permit traffic over unprotected floor joint surfaces.
- B. Provide strippable coating to protect finish surface.

END OF SECTION 07 95 13

SECTION 08 12 13
HOLLOW METAL FRAMES FOR WOOD DOORS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Non-rated and fire-rated hollow metal frames for wood doors.
- B. Non-rated and fire-rated hollow metal borrowed lite glazing frames.

1.03 RELATED SECTIONS

- A. Section 08 71 00 - Door Hardware.
- B. Section 08 80 00 - Glazing.
- C. Section 09 91 23 - Interior Painting.
- D. Section 13 49 13 - Integrated X-Ray Shielding Assemblies

1.04 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- B. ANSI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames. 1998 (R2011).
- C. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames 2015.
- D. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames 2015.
- E. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100) 2017.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- G. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable 2021a.
- H. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength 2018a.
- I. BHMA A156.115 - Hardware Preparation In Steel Doors And Steel Frames 2016.
- J. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.
- K. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames 2002.
- L. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames 2011.
- M. NAAMM HMMA 840 - Guide Specifications For Receipt, Storage and Installation of Hollow Metal Doors and Frames 2007.
- N. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames 2014.
- O. NFPA 257 - Standard on Fire Test for Window and Glass Block Assemblies 2022.
- P. UL 9 - Standard for Fire Tests of Window Assemblies Current Edition, Including All Revisions.
- Q. NFPA 80 - Standard for Fire Doors and Other Opening Protectives 2022.
- R. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives 2022.
- S. UL 1784 - Standard for Air Leakage Tests of Door Assemblies Current Edition, Including All Revisions.

01-17-2022

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures.
- B. 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.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.
- D. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.
- E. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.
- F. Manufacturer's Qualification Statement.
- G. Installer's Qualification Statement.

1.06 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.
- B. Fire-Rated Door Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated.
- C. Fire-Rated Borrowed Lite Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9. Label each individual glazed lite.
- D. Smoke-Control Door and Frame Assemblies: Comply with NFPA 105 or UL 1784.
- E. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.
- F. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Manufacturer: Products from Steelcraft are specified to establish a standard of quality for design, function, materials, and appearance.
- B. Other Manufacturers: The following manufacturers are approved to provide materials or products that are equivalent to the "Basis of Design":
 - 1. Ceco Door.
 - 2. Fleming Door Products.
 - 3. Mesker.
 - 4. Republic Doors.
 - 5. Amweld Building Products, LLC.
 - 6. Curries Company.
- C. Substitutions: Refer to Section 01 25 00 - Substitution Procedures.

2.02 DESIGN CRITERIA

- A. Requirements for Hollow Metal Frames:
 - 1. Steel used for fabrication of frames shall comply with one or more of the following requirements; Galvannealed steel conforming to ASTM A653/A653M, cold-rolled steel

01-17-2022

- conforming to ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel conforming to ASTM A1011/A1011M, Commercial Steel (CS) Type B for each.
- 2. Accessibility: Comply with ICC A117.1 and ADA Standards.
- 3. Door Edge Profile: Manufacturers standard for application indicated.
- 4. Typical Door Face Sheets: Flush.
- 5. Glazed Lites: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturers standard.
- 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: Metal components shall be zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvannealed) by the hot-dip process in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness, unless noted otherwise.
 - a. Interior Doors:
 - 1) Typical Locations: Provide at least A25/ZF75 (galvannealed) for interior applications
 - 2) Corrosive Locations: G60/Z180 (galvanized)
- B. Hollow Metal Panels: Same construction, performance, and finish as doors.
- C. 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.

2.03 HOLLOW METAL FRAMES

- A. Basis of Design Product/s: Steelcraft; as follows:
 - 1. F Series: Double rabbet, Single rabbet, and Cased opening set-up and welded frame.
 - 2. FE Series: Double egress, set-up and welded frame.
- B. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- C. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
 - 1. Frame Metal Thickness: 16 gage, 0.053 inch (1.3 mm), minimum.
 - 2. Frame Finish: Factory primed and field finished.
 - 3. Reinforcement: Provide high frequency hinge reinforcement at top hinge location.
- D. Interior Door Frames, Fire-Rated: Full profile/continuously welded type.
 - 1. Fire Rating: Same as door, labeled.
 - 2. Frame Metal Thickness: 16 gage, 0.053 inch (1.3 mm), minimum.
 - 3. Frame Finish: Factory primed and field finished.
- E. Frame Hardware Reinforcement:
 - 1. Mortise Hinge Reinforcements: 7 gauge, 0.180 inch, minimum.
 - 2. Strike Reinforcements: 16 gauge, 0.067 inch, minimum. Prep for an ANSI-A115.1-2 strike.
 - 3. Closer Reinforcements: 14 gauge, 0.067 inch, minimum.
 - 4. Projection weld hinge and strike reinforcements to the door frame.
 - 5. Minimum hardware reinforcing gages shall comply with Table 4 of ANSI/SDI A250.8.
- F. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.
- G. Mullions for Pairs of Doors: Removable type, with profile similar to jambs.
- H. Borrowed Lites / Glazing Frames: Construction and face dimensions to match door frames, and as indicated on drawings.
- I. Transom Bars: Fixed, of profile same as jamb and head.
- J. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.

01-17-2022

- K. Frames Wider than 48 inches (1219 mm): Reinforce with steel channel fitted tightly into frame head, flush with top.
- L. Frames Installed Back-to-Back: Reinforce with steel channels anchored to floor and overhead structure.

2.04 FINISHES

- A. Shop Prime Finish: Apply manufacturer's standard fast-curing, lead- and chromate-free primer, complying with ANSI A250.10 acceptance criteria; immediately after cleaning and pretreating. Primer shall be recommended by primer manufacturer for substrate and compatible with substrate and field-applied coatings.

2.05 FRAME ANCHORS

- A. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (1.0 mm) thick. Install quantities per a Paladin storm door requirement.
- B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch (1.0 mm) thick, and as follows:
 - 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.06 STOPS AND MOLDINGS

- A. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated.
- B. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch (0.8 mm) thick, fabricated from same material as frames in which they are installed.

2.07 ACCESSORIES

- A. Glazing: As specified in Section 08 80 00.
- B. Removable Stops: Formed sheet steel, shape as indicated on drawings, mitered or butted corners; prepared for countersink style tamper proof screws.
- C. Astragals for Double Doors:
 - 1. Fire-Rated Doors: Steel, shape as required for fire rating.
- D. Mechanical Fasteners for Concealed Metal-to-Metal Connections: Self-drilling, self-tapping, steel with electroplated zinc finish.
- E. Grout for Frames: Portland cement grout with maximum 4 inch (102 mm) slump for hand troweling; thinner pumpable grout is prohibited.
- F. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
- G. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

2.08 FABRICATION

- A. Fabricate hollow metal frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.
- C. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.

01-17-2022

4. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
5. All frames shall be delivered with factory installed spreaders.
6. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Fire ratings may require additional anchors.
 - b. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches (1524 mm) high.
 - 2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
 - 3) Two anchors per head for frames above 42 inches (1066 mm) wide and mounted in metal-stud partitions.
7. Door Silencers: Drill stops to receive door silencers as follows.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
 - c. Keep holes clear during construction.
- D. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.
- E. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
 1. Locate hardware as indicated according to ANSI/SDI A250.6.
 2. Reinforce frames to receive nontemplated, mortised and surface-mounted door hardware.
 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
 4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 and 28 Sections.
- F. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
 1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 3. Provide fixed frame moldings on secure side of interior door frames.
 4. Provide loose stops and moldings on inside of hollow metal work.
 5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that opening sizes and tolerances are acceptable.
- B. Verify that finished walls are in plane to ensure proper door alignment.

3.02 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness.
 1. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 2. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.

01-17-2022

3. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.

C. Drill and tap frames to receive non-templated, mortised, and surface-mounted door hardware.

3.03 INSTALLATION

- A. Install door frames in accordance with manufacturer's instructions and RELATED SECTIONS 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.
- D. Install door hardware as specified in Section 08 71 00.
 1. Comply with recommended practice for hardware placement in accordance with ANSI/SDI A250.6 or NAAMM HMMA 861.
- E. Comply with glazing installation requirements of Section 08 80 00.
- F. Coordinate installation of electrical connections to electrical hardware items.
- G. Prime Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

3.04 ADJUSTING

- A. Adjust for smooth and balanced door movement.

3.05 FRAME SCHEDULE

- A. Refer to Door and Frame Schedule on Sheet A4.1.

END OF SECTION 08 12 13

SECTION 08 14 16
FLUSH WOOD VENEER DOORS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Solid core doors with wood veneer faces, non-rated and fire-rated.

1.03 RELATED SECTIONS

- A. Section 08 11 13 - Hollow Metal Doors and Frames
- B. Section 08 71 00 - Door Hardware
- C. Section 08 80 00 - Glazing.

1.04 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials Current Edition.
- B. ANSI A208.1 - American National Standard for Particleboard 2016.
- C. NFPA 80 - Standard for Fire Doors and Other Opening Protectives 2022.
- D. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives 2022.
- E. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies 2022.
- F. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies Current Edition, Including All Revisions.
- G. WDMA I.S. 1A - Interior Architectural Wood Flush Doors 2013.

1.05 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00 - Submittal Procedures.
- B. Product Data: Submit manufacturer's product data, including door construction description and WDMA I.S.1-A and AWS classifications.
- C. Schedules: Submit manufacturer's schedules, including door dimensions, cutouts, species, finish, and hardware. Reference individual door numbers as indicated on the Drawings.
- D. 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.
- E. Samples for Initial Selection: Submit two samples of door veneer, 6 by 6 inch (____ by ____ mm) in size illustrating wood grain, stain color, and sheen.
- F. Samples for Verification:
 - 1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches (200 by 250 mm), for each material and finish.
 - 2. Corner sections of doors, approximately 8 by 10 inches (200 by 250 mm), with door faces and edges representing actual materials to be used.
 - a. Provide samples for each species of veneer and solid lumber required, with factory stain finish range as selected by Architect.
 - b. Finish veneer-faced door samples with same materials proposed for factory-finished doors.
 - 3. Frames for light openings, 6 inches (150 mm) long, for each material, type, and finish required.

1.06 QUALITY ASSURANCE

- A. Tolerances for Warp, Telegraphing, Squareness, and Prefitting Dimensions: WDMA I.S.1-A.
- B. Identifying Label: Each door shall bear identifying label indicating:
 - 1. Door manufacturer.

01-17-2022

2. Order number.
 3. Door number.
 4. Fire rating, if applicable.
- C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252.
1. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
 2. Labeled by Intertek/Warnock Hersey.
 - a. Construction Details and Hardware Application: Approved by labeling agency.
 3. Positive Pressure Opening Assemblies: UL 10C.
- D. Environmental Responsibility: Provide doors manufactured with the following environmentally responsible components:
1. Core:
 - a. Agrifiber Core:
 - 1) Rapidly renewable materials.
 - 2) Pre-consumer recycled content.
 - 3) No added urea formaldehyde.
 - b. Particleboard Core:
 - 1) Forest Stewardship Council (FSC) certified.
 - 2) Pre-consumer recycled material.
 - 3) No added urea formaldehyde.
 - c. Stave Lumber Core:
 - 1) Forest Stewardship Council (FSC) certified.
 - 2) No added urea formaldehyde.
 - d. Structural Composite Lumber (SCL) Core:
 - 1) Forest Stewardship Council (FSC) certified.
 - 2) No added urea formaldehyde.
 2. Composite Crossband:
 - a. High-Density Fiberboard (HDF):
 - 1) Forest Stewardship Council (FSC) certified.
 - 2) Pre-consumer recycled material.
 - 3) No added urea formaldehyde.
 3. Stiles and Rails:
 - a. Structural Composite Lumber (SCL):
 - 1) Forest Stewardship Council (FSC) certified.
 - 2) No added urea formaldehyde.
 4. GREENGUARD Certification Program.
 - a. GREENGUARD Indoor Air Quality Certified.
 - b. GREENGUARD Children and Schools Certified.

1.07 DELIVERY, STORAGE, AND HANDLING

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

1.08 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed, wet work in spaces is complete and dry, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 43 and 70 percent during the remainder of the construction period.

1.09 WARRANTY

- A. Manufacturers' Warranty: Warrant flush wood veneer doors for life of installation against warpage, delamination, and defects in materials and workmanship.
 - 1. Defects noted during warranty period shall be corrected at no cost to Owner. Corrective work shall include labor and material for repair, replacement, refinishing, and rehanging as required.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Specified Manufacturer: V.T. Industries
 - 1. Other Acceptable Manufacturer: None identified. No substitutions will be considered or accepted.
- B. Source Limitations: Obtain flush wood doors from single manufacturer.

2.02 SOLID CORE WOOD DOORS, NON-RATED & 20-MINUTE

- A. Basis of Design Product: V.T. Industries; "Heritage" Collection, 5-Ply Bonded Doors.
 - 1. Door Type, Manufacturer, Model Number, and Core Type:
 - a. Non-Rated Doors: VTI; Model No. 5502H, with PC-5 particleboard core.
 - b. 20-Minute Rated Doors: VTI; Model No. 5502H, with PC-20-5 particleboard core.
 - c. 20-Minute Rated, Positive Pressure Doors: VTI; Model No. 5P02H, with PC-20PP-5 particleboard core.
- B. Seven-ply and non-bonded core construction is not acceptable.
- C. Compliance: WDMA I.S. 1A.
 - 1. Aesthetic Grade: Custom Grade.
 - 2. Duty Level: Extra Heavy Duty.
 - 3. Core Type: PC-5.
- D. Door Thickness: 1-3/4 inches (44 mm).
- E. Stiles:
 - 1. Inner Stiles: 1-3/8 inches wide, before pre-fitting.
 - 2. Structural Composite Lumber (SCL) With Outer Stile: Same species as face veneer.
 - 3. Outer Stile: Apply after beveling and before face application.
- F. Rails:
 - 1. Structural composite lumber (SCL).
 - 2. Width before pre-fitting: 1-3/8 inches, minimum.
- G. Cores:
 - 1. Material: Particleboard.
 - 2. Particleboard and Agrifiber Compliance: ANSI A208.1, Grade 1-LD-2.
 - 3. Stave Lumber Core Compliance: Blocks and strips not more than 2-1/2 inches wide, one species of wood.
- H. Door Assembly:
 - 1. Stiles and Rails: Bonded to core.
 - 2. Sand entire assembly flat as a unit to ensure minimal telegraphing of core components through face veneers.
- I. Composite Crossbands:
 - 1. Apply to core in hot press using Type I, exterior, water-resistant adhesive, before application of hardwood edges.
 - 2. Exposed Crossbanding: Not allowed along stile edges.
- J. Veneers:
 - 1. Apply to crossbanded core in hot press using Type I, exterior, water-resistant adhesive.
 - 2. Refer to "Door Facings" Article this Section for veneer species, cut, match and assembly.
- K. Positive Pressure Doors:

01-17-2022

1. Where UL 10C standards for positive pressure apply, doors shall be constructed in accordance with Category A guidelines as published by Intertek/Warnock Hersey.
 2. Smoke Gasketing: Apply smoke gasketing around frame perimeter and between door and pairs to meet Smoke (S) rating.
 3. Intertek/Warnock Hersey Category A Guidelines: Edge sealing systems not allowed on frames.
- L. Provide "VTSmartdoor" electronic barcode on all 20-minute rated doors:
1. Location: Fire label, hinge stile of doors.
 2. Provide fire-rated door assembly information required for Owner's annual fire-door inspection in accordance with NFPA 80, Paragraph 5.2.1.
- M. Transom Panels: Same construction and finish as door; same performance rating as door.

2.03 SOLID CORE WOOD DOORS, FIRE RATED

- A. Basis of Design Product: VTI; "Heritage Collection", 5-Ply Flush Fire-Rated Wood Doors.
- B. Door Type, Model Number, and Core Type:
1. 45-Minute Rated Doors:
 - a. Model No. 5545H; FD-45-5 mineral core.
 - b. Model No. 5P45H; FD-45PP-5 mineral core, positive pressure.
 2. 60-Minute Rated Doors:
 - a. Model No. 5511H; FD-60-5 mineral core.
 - b. Model No. 5P11H; FD-60PP-5 mineral core, positive pressure.
 3. 90-Minute Rated Doors:
 - a. Model No. 5511H; FD-90-5 mineral core.
 - b. Model No. 5P11H; FD-90PP-5 mineral core, positive pressure.
 4. Compliance: WDMA I.S. 1A.
 - a. Aesthetic Grade: Custom Grade.
 - b. Duty Level: Extra Heavy Duty.
 - c. Type: FD-XX-5 or FD-XXPP-5 (XX = 45-, 60-, or 90-minute fire rating).
- C. Door Thickness: 1-3/4 inches (44 mm).
- D. Outer Edges: Same species as face veneer.
- E. Inner Stiles: Structural composite lumber (SCL).
- F. Rails:
1. Structural composite lumber (SCL).
 2. Width: Manufacturer's standard width.
- G. Core:
1. 5-ply fire-retardent mineral core (FD) that does not contain asbestos or added urea formaldehyde.
 2. Provide core blocking as required to provide adequate anchorage of hardware without through-bolting.
- H. Composite Crossbands:
1. Apply to core in hot press using Type I, exterior, water-resistant adhesive before application of hardwood edges.
 2. Exposed Crossbanding: Not allowed along stile edges.
- I. Veneers:
1. Apply to crossbanded core in hot press using Type I, exterior, water-resistant adhesive.
 2. Refer to "Door Facings" Article this Section for veneer species, cut, match and assembly.
- J. Positive Pressure: 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.
- K. Smoke and Draft Control Doors (Indicated as "S" on Drawings): In addition to required fire rating, provide flush wood door assemblies in compliance with WDMA I.S. 1A requirements for

"S" label; no additional gasketing or edge sealing allowed.

- L. Provide "VTSmartdoor" electronic barcode on all fire-rated doors:
 - 1. Location: Fire label, hinge stile of doors.
 - 2. Provide fire-rated door assembly information required for Owner's annual fire-door inspection in accordance with NFPA 80, Paragraph 5.2.1.

2.04 DOOR FACINGS

- A. Apply veneers to crossbanded core in hot press using Type I, exterior, water-resistant adhesive.
- B. Veneer Facing for Transparent Finish:
 - 1. Species: Selected by Architect from manufacturer's standard finishes.
 - 2. Grade: HPVA Grade A.
 - 3. Cut: plain sliced (flat cut).
 - 4. Veneer Leaf Matching: book match.
 - 5. Matching Within a Veneer Face: running match.
 - 6. Vertical Edges: Same species as face veneer.
 - a. Bevel: 3-degrees each stile.
 - 7. "Pair Match" each pair of doors; "Set Match" pairs of doors within 10 feet (3 m) of each other when doors are closed.
 - 8. Transoms: Continuous match to doors.

2.05 FINISHES

- A. Doors shall receive factory finishing.
- B. Finish work in accordance with WDMA I.S. 1A for grade specified and as follows:
 - 1. Transparent:
 - a. System - TR-8, UV Cured Acrylated Polyester/Urethane, premium grade.
 - 1) Stain coat.
 - 2) Sealer: 3 coats.
 - 3) Sanding: Sand.
 - 4) Topcoat: 2 coats.
 - b. Finish Name: TBD.
 - c. Finish #: TBD
 - d. Sheen: Satin.
- C. Top and Bottom Rails: Factory sealed.
- D. Seal door top edge with color sealer to match door facing.

2.06 ACCESSORIES

- A. Hollow Metal Door Frames: Refer to Section 08 11 13.
- B. Glazed Openings: Refer to Section 08 80 00.
 - 1. Provide heat-strengthened, fully-tempered, laminated, insulating, or fire-rated glass as needed.
- C. Glass Lite Mouldings:
 - 1. Non-rated Flush Doors: VT Industries; Style VT1 (1/4" Glass); Flush wood lite mouldings:
 - a. Flush wood lite mouldings have one side fixed into place with brads at the factory. The other side is temporarily tacked into place so glass and glazing can be installed at the jobsite. Field fitting of glass and glazing is the responsibility of the installer. Use of a glazing compound or caulking is recommended to reduce glass rattle. All profiles have a tolerance of ± 0.005 inches.
 - b. Wood Moulding Material: Match the face veneer on the door.
 - 2. 20-Minute Rated Flush Doors:
 - a. Flush Wood Lite Mouldings: VT Industries; Style VT1 (1/4" Glass) with metal glazing clips:
 - 1) Wood lite mouldings have one side fixed into place with brads at the factory, along with one-half of Fire Clip™. The other side is temporarily tacked into place

- so glass and glazing can be installed at the jobsite. Remaining halves of Fire Clips™ are shipped loose, to be installed with glass. Field fitting of glass and glazing is the responsibility of the installer. Use of a glazing compound or caulking is required. All profiles have a tolerance of ±0.005 inches.
- 2) Wood Moulding Material: Match the face veneer on the door.
 - b. Metal Vision Frame:
 - 1) Basis of Design Product: VT Industries; Style #110 Metal Vision Frame.
 - (a) Material: Frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet.
 - (b) Finish: Factory primed for field-applied paint finish.
 - (c) Glass Thickness: As scheduled.
 - 3. 45-, 60- and 90-Minute Fire-Rated Doors:
 - a. Metal Vision Frame:
 - 1) Basis of Design Product: VT Industries; Style #110 Metal Vision Frame.
 - (a) Material: Frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet.
 - (b) Finish: Factory primed for field-applied paint finish.
 - (c) Glass Thickness: As scheduled.
 - D. Astragals:
 - 1. Astragals for Non-Rated Double Doors: Steel, T shaped, overlapping and recessed at face edge.
 - 2. Astragals for Fire-Rated Double Doors: Steel, T shaped, overlapping and recessed at face edge, specifically for double doors.
 - E. Door Hardware: As specified in Section 08 71 00.

2.07 FABRICATION

- A. Fabricate doors in accordance with door quality standard specified.
- B. Cores Constructed with stiles and rails:
 - 1. Five plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering. Faces are bonded to core using a hot press.
 - 2. Provide solid blocks at lock edge for hardware reinforcement.
 - 3. Provide solid blocking for other throughbolted hardware.
- C. Where supplementary protective edge trim is required, install trim after veneer facing has been applied full-width.
- D. Prefit Doors:
 - 1. Prefit and bevel doors at factory to fit openings.
 - 2. Prefit Tolerances: WDMA I.S. 1A and AWS Section 9.
- E. Hardware:
 - 1. Factory-machine doors for mortised hardware, including pilot holes for hinge screws and lock fronts required.
 - 2. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- F. Glazed Openings in Doors:
 - 1. Refer to "Accessories" Article this Section for light frame types.
 - 2. Provide non-removable stops on non-secure side; sizes and configurations as indicated on drawings.
- G. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
 - 1. Exception: Doors to be field finished.
- H. Provide edge clearances in accordance with the quality standard specified.
- I. Undercut:
 - 1. Bottom of Door: 5/8 inch.

2. Top and Sides: 1/8 inch.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine locations to receive doors. Notify Architect of conditions that would adversely affect installation or subsequent use. Do not begin installation until unacceptable conditions are corrected.
- B. Ensure frames are solidly anchored, allowing no deflection when doors are installed.
- C. Ensure frames are plumb, level, square, and within tolerance.

3.02 PREPARATION

- A. Allow doors to become acclimated to building temperature and relative humidity for a minimum of 24 hours before installation.

3.03 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.
 - 2. Install smoke and draft control doors in accordance with NFPA 105 requirements.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Use machine tools to cut or drill for hardware.
- D. Coordinate installation of doors with installation of frames, hardware, and glazing.
- E. Doors, operators, and frame mounted equipment interlocks shall be installed by the manufacturer and as indicated on the approved shop drawings. Touch up shop applied prime coat as required and ready for finish paint.
 - 1. Door speeds: Set by the manufacturer to comply with ANSI 156.10-2005
 - 2. Electrical connections: Frame mounted equipment interlocks shall be connected to the electrical distribution system under Division 26 - Electrical.

3.04 TOLERANCES

- A. Conform to specified quality standard for fit and clearance tolerances.
- B. Conform to specified quality standard for telegraphing, warp, and squareness.
- C. Maximum variation from plumb or level: 1/8 inch.
- D. Maximum offset from true dimensional alignment: 1/8 inch.

3.05 ADJUSTING

- A. Adjust doors to swing freely, without binding in frame.
- B. Adjust hardware to operate properly.
- C. Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect.
- D. Remove and replace damaged doors that cannot be successfully repaired, as determined by Architect.

3.06 CLEANING

- A. Clean doors promptly after installation in accordance with manufacturer's instructions.
- B. Do not use harsh cleaning materials or methods that could damage finish.

3.07 PROTECTION

- A. Protect installed doors from damage during construction.

END OF SECTION 08 14 16

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

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Wall and ceiling access door and frame units.

1.03 RELATED SECTIONS

- A. Section 09 91 23 - Interior Painting: Field paint finish.

1.04 REFERENCE STANDARDS

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures.
- B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.
- C. Shop Drawings:
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Detail fabrication and installation of access doors and frames for each type of substrate.
- D. Manufacturer's Installation Instructions: Indicate installation requirements.

1.06 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics according to the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. NFPA 252 or UL 10C for fire-rated access door assemblies installed vertically.
 - 2. Provide smoke gasketing for doors in 0 or 1 hour rated smoke partitions.

2.02 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- C. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.03 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports

01-17-2022

indicated.

1. For concealed flanges with drywall bead, provide edge trim for gypsum board securely attached to perimeter of frames.
 2. Provide mounting holes in frames for attachment of units to metal framing.
- D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

2.04 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Steel Finishes:
1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

2.05 ACCESS DOORS AND PANELS ASSEMBLIES

- A. Basis-of-Design Manufacturer and Product: Products from Acudoor Products, Inc. are specified to establish a standard of quality for design, function, materials, and appearance.
1. Other Manufacturers: The following manufacturers are approved to provide materials or products that are equivalent to the "Basis of Design":
 - a. J. L. Industries, Inc. (Activar Construction Products Group)
 - b. Babcock-Davis
 - c. Cendrex, Inc.
 - d. Karp Associates, Inc.
 - e. Milcor Inc.
 - f. Nystrom, Inc.
 2. Substitutions: Refer to Section 01 25 00.

2.06 WALL-MOUNTED ACCESS DOORS / PANELS

- A. Wall-Mounted Units:
1. Basis of Design: Acudoor, Model No. DW-5058.
 2. Location: As indicated on drawings.
 3. Material: Steel.
 4. Size: 12 inch by 12 inch (305 mm by 305 mm) unless noted otherwise.
 5. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
 6. Wall Mounting Criteria: Provide surface-mounted face frame and door surface flush with frame surface.
- B. Fire-Rated Wall-Mounted Units:
1. Basis of Design: Acudoor, Model No. FW-5015.
 2. Location: As indicated on drawings.
 3. Fire-Rating: As indicated on drawings, 2 hours or less.
 4. Material: Steel.
 5. Size: 12 inch by 12 inch (305 mm by 305 mm) unless noted otherwise.
 6. Door/Panel: Insulated double-surface panel, with tool-operated spring or cam lock and no handle.

2.07 CEILING-MOUNTED ACCESS DOORS / PANELS

- A. Ceiling-Mounted Units:
1. Basis of Design: Acudoor, Model No. DW-5058.
 2. Location: As indicated on drawings.
 3. Material: Steel.

01-17-2022

4. Size - Lay-In Grid Ceilings: To match module of ceiling grid.
 5. Size - Other Ceilings: 12 inch by 12 inch (305 mm by 305 mm) unless noted otherwise.
 6. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
- B. Fire-Rated Ceiling-Mounted Units:
1. Basis of Design: Acudoor, Model No. FWC-5015.
 2. Location: As indicated on drawings.
 3. Fire-Rating: As indicated on drawings, 2 hours or less.
 4. Material: Steel.
 5. Size: 12 inch by 12 inch (305 mm by 305 mm) unless noted otherwise.
 6. Door/Panel: Insulated double-surface panel, with tool-operated spring or cam lock and no handle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings are correctly sized and located.
- B. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare surfaces using methods recommended by manufacturer for applicable substrates in accordance with project conditions.

3.03 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.

3.04 ADJUSTING

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

END OF SECTION 08 31 00

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SECTION 08 43 13
ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Exterior aluminum storefront framing for window walls and/or punched openings.
- B. Exterior entrance doors and frames.

1.03 RELATED SECTIONS

- A. Section 06 10 00 - Rough Carpentry
- B. Section 07 62 00 - Sheet Metal Flashing and Trim
- C. Section 07 92 00 - Joint Sealants
- D. Section 08 71 00 - Door Hardware.
- E. Section 08 80 00 - Glazing

1.04 PERFORMANCE REQUIREMENTS

- A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
 - 1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
 - 2. Dimensional tolerances of building frame and other adjacent construction.
 - 3. Failure includes the following:
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferring to building structure.
 - c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
 - d. Glazing-to-glazing contact.
 - e. Noise or vibration created by wind and by thermal and structural movements.
 - f. Loosening or weakening of fasteners, attachments, and other components.
 - g. Sealant failure.
 - h. Failure of operating units.
- B. Delegated Design: Design storefront systems, including comprehensive engineering analysis by a qualified professional engineer, using the following design criteria:
 - 1. Structural load information: Based on the 2012 International Building Code and the structural drawings.
- C. Performance Requirements:
 - 1. Air Infiltration Test: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E283, at a minimum static-air-pressure difference of 6.24 lbf/sq. ft. (300 Pa).
 - a. Air infiltration shall not exceed 0.06 cfm/sq. ft. (0.03 L/s per sq. m)
 - 2. Water Resistance Test
 - a. Test unit in accordance with ASTM E331.
 - b. There shall be no uncontrolled water leakage at a static test pressure of 12.0 psf (575 Pa).
 - 3. Water Penetration under Dynamic Pressure: Provide aluminum-framed systems that do not evidence water leakage through fixed glazing and framing areas when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa)].

01-17-2022

- a. Maximum Water Leakage: According to AAMA 501.1 No uncontrolled water penetrating aluminum-framed systems or water appearing on systems' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior and water that cannot damage adjacent materials or finishes.
4. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - a. Temperature Change (Range): 0 deg F (-18 deg C); 180 deg F (82 deg C), material surfaces.
 - b. Test Interior Ambient-Air Temperature: 75 deg F (24 deg C).
 - c. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5 for a minimum 3 cycles.
5. Condensation Resistance (CR): Provide aluminum-framed systems with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 53 when tested according to AAMA 1503.
6. Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having an average U-factor of not more than 0.47 Btu/sq. ft. x h x deg F (3.23 W/sq. m x K) when tested according to AAMA 1503 with Low-e glass.
7. Sound Transmission: Provide aluminum-framed systems with fixed glazing and framing areas having the following sound-transmission characteristics:
 - a. Sound Transmission Class (STC): Minimum 38 STC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E413.
 - b. Outdoor-Indoor Transmission Class (OITC): Minimum 31 OITC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E1332.
8. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by aluminum-framed systems without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
 - a. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
 - b. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
9. Structural-Sealant Joints: Designed to produce tensile or shear stress of less than 20 psi (138 kPa).

1.05 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems.
- B. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.
 1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.
 2. For entrance doors, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Fabrication Sample: Of each vertical-to-horizontal intersection of aluminum-framed systems, made from 12-inch (300-mm) lengths of full-size components and showing details of the a)

01-17-2022

Joinery (including concealed welds); b) anchorage; c) expansion provisions; d) glazing; e) flashing and drainage.

F. Other Action Submittals:

1. Entrance Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

G. Delegated-Design Submittal: For aluminum-framed systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of aluminum-framed systems.

2. Include design calculations.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and testing agency.

B. Seismic Qualification Certificates: For aluminum-framed systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

C. Welding certificates.

D. Preconstruction Test Reports: For sealant.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for aluminum-framed systems, indicating compliance with performance requirements.

F. Source quality-control reports.

G. Field quality-control reports.

H. Warranties: Sample of special warranties.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance Data: For aluminum-framed systems to include in maintenance manuals.

1.08 QUALITY ASSURANCE

A. Test reports shall be accompanied by the storefront manufacturer's letter of certification stating that the tested storefront meets or exceeds the requirements of the 2015 IECC.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

C. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.

D. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.

E. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

F. Accessible Entrances: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC

01-17-2022

A117.1.

- G. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.
- H. Structural-Sealant Glazing: Comply with ASTM C1401, "Guide for Structural Sealant Glazing" for design and installation of structural-sealant-glazed systems.
- I. Structural-Sealant Joints: Design reviewed and approved by structural-sealant manufacturer.
- J. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.09 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 WARRANTY

- A. Installation Warranty: The responsible contractor shall assume full responsibility during the warranty period for the satisfactory performance of the total storefront installation.
 - 1. Warranty Period: One (1) year from Date of Substantial Completion.
- B. Manufacturer Warranty: Manufacturer shall warrant the product/s, including aluminum finish, to be free of defects in material and workmanship for a period of three (3) years from Date of Substantial Completion.
- C. Glass Warranty: Warrant the insulated glass units will be free from obstruction of vision as a result of dust or film formation on the internal glass surfaces caused by failure of the hermetic seal due to defects in material and workmanship during the warranty period.
 - 1. Warranty Period: Ten (10) years from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Manufacturer: Products from Kawneer Corporation are specified to establish a standard of quality for design, function, materials, and appearance.
 - 1. Other Manufacturers: The following manufacturers are approved to provide materials or products that are comparable to the "Basis of Design":
 - a. Tubelite
 - b. EFCO Corporation
 - c. Manko Window Systems, Inc
 - d. Special-Lite

2.02 MATERIALS

- A. Aluminum Extrusions: Alloy and temper recommended by aluminum storefront manufacturer for strength, corrosion resistance, and application of required finish and not less than 0.070" (1.8 mm) wall thickness at any location for the main frame and complying with ASTM B221: 6063-T6 alloy and temper.
- B. Fasteners: Aluminum, nonmagnetic stainless steel or other materials to be non-corrosive and compatible with aluminum framing members, trim hardware, anchors, and other components.
- C. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.
- D. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.
- E. Sealant: For sealants required within fabricated storefront system, provide permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and

01-17-2022

movement.

- F. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of storefront members are nominal and in compliance with AA Aluminum Standards and Data.

2.03 EXTERIOR STOREFRONT FRAMING SYSTEM

- A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads:
 - 1. Basis of Design Product: Kawneer Tri-Fab VG 451T, Thermally broken storefront system.
- B. Properties:
 - 1. System Dimensions: 2 inch x 4-1/2 inches (50.8 mm x 114.3 mm)
 - 2. Glazing Plane: Exterior.
 - 3. Glazing System: Retained mechanically with gaskets on four sides.
 - 4. Kawneer IsoLock™ Thermal Break with a 1/4" (6.4 mm) separation consisting of a two-part chemically curing, high-density polyurethane, which is mechanically and adhesively joined to aluminum storefront sections.
 - a. Thermal Break shall be designed in accordance with AAMA TIR-A8 and tested in accordance with AAMA 505.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials. Where exposed shall be stainless steel.
- E. Perimeter Anchors: When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.
- F. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.
 - 1. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.04 MATERIALS

- A. Aluminum
 - 1. Extruded aluminum shall be 6063-T6 alloy and temper.
- B. Glazing: Refer to Section 08 80 00.
- C. Thermal Barrier:
 - 1. All exterior aluminum shall be separated from interior aluminum by a rigid, structural thermal barrier. For purposes of this specification, a structural thermal barrier is defined as a system that shall transfer shear during bending and, therefore, promote composite action between the exterior and interior extrusions.
 - 2. Barrier material shall be poured-in-place, two-part polyurethane. A nonstructural thermal barrier is unacceptable.
- D. Glazing Gaskets: Manufacturer's standard compression types; replaceable, extruded EPDM rubber.
- E. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.
- F. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.
- G. Glazing Sealants: For structural-sealant-glazed systems, as recommended by manufacturer for joint type, and as follows:
 - 1. Structural Sealant: ASTM C1184, single-component neutral-curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by a structural-sealant manufacturer for use in aluminum-framed systems indicated.
 - a. Color: Black

01-17-2022

2. Weatherseal Sealant: ASTM C920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; single-component neutral-curing formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural sealant, weatherseal-sealant, and aluminum-framed-system manufacturers for this use.
 - a. Color: Matching structural sealant.

2.05 ENTRANCE DOORS

- A. Entrance Doors: Manufacturer's glazed full-lite entrance doors, manual-swing operation.
 1. Product: Kawneer 500 Swing Door, Wide stile.
- B. Properties:
 1. Overall thickness: 1 3/4-inches, with minimum 0.125-inch thick extruded-aluminum tubular rail and stile members.
 2. Medium Stile Doors:
 - a. Vertical Stiles: 3-1/2 inches wide.
 - b. Top Rail: 5-inches high.
 - c. Bottom Rail: 6-1/2 inches high.
 - d. Intermediate Rail for mounting of panic hardware: 8-1/4 inches high.
 3. Glazing Stops and Gaskets: Square, extruded-aluminum stops shaped to accommodate 1/4-inch or 1-inch glazing with manufacturer's standard glazing gaskets.
 - a. Provide non-removable glazing stops at exterior side of doors and storefronts.
- C. Entrance Door Hardware: As specified below.

2.06 DOOR HARDWARE

- A. General: Provide entrance door hardware sets specified in Section 08 71 00.
 1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.
 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
- B. Opening-Force Requirements:
 1. Egress Doors: Not more than 15 lbf (67 N) to release the latch and not more than 30 lbf (133 N) to set the door in motion and not more than 15 lbf (67 N) to open the door to its minimum required width.
 2. Accessible Interior Doors: Not more than 5 lbf (22.2 N) to fully open door.

2.07 ACCESSORY MATERIALS

- A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Section 07 92 00 - Joint Sealants.
 1. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil (0.762-mm) thickness per coat.

2.08 FINISHES

- A. Kawneer Permanodic™ AA-M10C21A44 / AA-M45C22A44, AAMA 611, Architectural Class I Color Anodic Coating.
 1. Color: Champagne

2.09 FABRICATION

- A. General
 1. All aluminum frame extrusions shall have a minimum wall thickness of .080-inches (2 mm).
 2. All exposed work shall be carefully matched to produce continuity of line and design with all joints. System design shall be such that raw edges will not be visible at joints.
- B. Exterior Frame

01-17-2022

1. Depth of frame shall not be less than 4-1/2 inches (114 mm).
 2. Face dimension shall not be less than 2-inches (50 mm).
 3. Frame components shall be shear block construction.
- C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformations.
 2. Accurately fitted joints with ends coped or mitered.
 3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
 4. Physical and thermal isolation of glazing from framing members.
 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 6. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing or metal panels.
 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.
- F. Storefront Framing: Fabricate components for assembly using shear-block system.
- G. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
1. At exterior doors, provide compression weather stripping at fixed stops.
 2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
- H. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
 2. At exterior doors, provide weather sweeps applied to door bottoms.
- I. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- J. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A. General:
 1. Comply with manufacturer's written instructions.
 2. Do not install damaged components.
 3. Fit joints to produce hairline joints free of burrs and distortion.
 4. Rigidly secure nonmovement joints.
 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
 6. Seal joints watertight unless otherwise indicated.
- B. Metal Protection:

01-17-2022

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
- D. Set continuous sill members and flashing in full sealant bed as specified in Section 07 92 00 - Joint Sealants to produce weathertight installation.
- E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.
- F. Install glazing as specified in Section 08 80 00.
- G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
 2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
- H. Install perimeter joint sealants as specified in Section 07 92 00 - Joint Sealants to produce weathertight installation.

3.03 ERECTION TOLERANCES

- A. Install aluminum-framed systems to comply with the following maximum erection tolerances:
1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/4 inch (6 mm) over total length.
 2. Alignment:
 - a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch (1.5 mm).
 - b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch (0.8 mm).
- B. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch (3 mm).

3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide periodic site visit by manufacturer's field service representative.

3.05 ADJUSTING, CLEANING, AND PROTECTION

- A. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer.
- B. Clean aluminum surfaces immediately after installing aluminum-framed entrance doors. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
- C. Clean glass immediately after installation. Comply with glass manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.
- D. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- E. Protect installed systems from damage.

END OF SECTION 08 43 13

**SECTION 08710
DOOR HARDWARE**

PART 1 - GENERAL

1.1 The Requirements

- A. As set forth in the headings of General Conditions, Supplementary General Conditions, and Division 1, General Requirements shall apply to this branch of the work.

1.2 Summary

- A. Intent: The intent of this Section is to provide finish hardware for the proper operation and control of all wood, hollow metal and aluminum doors in the Project. Prior to bidding, notify the Architect of any doors that do not have hardware meeting this intention.
- B. The hardware supplier will be responsible to furnish correct hardware on labeled doors to satisfy State and Local Building Codes.
- C. Should items of hardware, not definitely specified, be required for completion of work, furnish such items of type and quality suitable to the services required and comparable to the adjacent hardware.
- D. Related work in other sections:
 - 1. Hollow metal doors; frames and silencers: Section 08100.
 - 2. Wood doors: Section 08210.
 - 3. Aluminum doors: Section 0840.

1.3 Submittals

- A. Comply with requirements of the Conditions of the Contract and Section 01300.
- B. Product Data: Submit manufacturer's technical product data for each hardware item. Include information necessary to show compliance with requirements, and include instructions for installation and for maintenance of operating parts and finishes.
- C. Hardware Schedule: Submit a hardware schedule in a vertical format (horizontal format not acceptable), organized into sets, including the information below. Designations for door numbers and hardware sets in the schedule shall match those used in the Construction Documents.
 - 1. Hardware Schedule shall be coordinated with doors, frames, and related work to ensure proper size, thickness, hand function, and finish of door hardware. Provide index at end of submittal listing door and-specified hardware. In addition, indicate page on submittal where door is found.
 - 2. Catalog cuts of each type of exposed hardware unit, highlighted in color to indicate compliance with the Hardware Schedule.
 - a. Type, style, function, size and finish of each hardware item.
 - b. Name and manufacturer of each item.
 - c. Fastenings and other pertinent information.

- d. Explanation of all abbreviations, symbols, codes, etc., contained in schedule.
 - e. Mounting locations for hardware.
 - f. Door and frame sizes and materials.
 - g. Deviations from Specifications shall be noted in cover letter.
3. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication and control of the access control system electrified hardware and firmware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
- a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
4. Electrical Coordination: Coordinate with related Electrical Sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Submittal Sequence: Submit schedule at earliest possible date particularly where acceptance of hardware schedule must precede fabrication of other work (e.g., hollow metal frames), which is critical in the project construction schedule. Include with schedule the product data, samples, shop drawings of other work affected by finish hardware, and other information essential to the coordinated review of hardware schedule.
- E. Keying Schedule: Submit separate detailed schedule indicating keying for all locks. Keying schedule must be approved before ordering any locks.
- F. Templates: Furnish hardware templates to each fabricator of doors, frames and other work. To be factory-prepared for the installation of hardware: Upon request check shop drawings of such other work, to confirm that adequate provisions are made for proper location and installation of hardware.

1.4 Quality Assurance

- A. Supplier Qualifications: A recognized Architectural Finish Hardware Supplier, with warehousing facilities, who has been furnishing hardware in the Project's vicinity for a period of not less than two (2) years. Supplier shall be or employ an experienced Architectural Hardware Consultant (AHC) who is certified by and member of the Door and Hardware Institute. The Architectural hardware Consultant shall be available, at reasonable times during the course of the work, for consultation about Project's hardware requirements, to Owner, Architect and Contractor.
- B. Fire-Rated Openings: Provide hardware for fire-rated openings in compliance with NFPA Standard No. 80, No. 101 and local building code requirements. Provide only hardware, which has been tested and listed, by UL, FM or Warnock Hersey for types and sizes of doors required and complies with requirements of door and door frame labels.
- 1. Where emergency exit devices are required on fire-rated doors, (with supplementary marking on doors' UL or FM labels indicating "Fire Door to be Equipped with Fire Exit Hardware") provide UL or FM label on exit devices indicating "Fire Exit Hardware".
- C. Standards: Comply with the requirements of the latest edition of the following standards, unless indicated otherwise:

1. American National Standards Institute (ANSI) Publications:
 - a. A115 Series - Door and Frame Preparation
 - b. A156 Series -Hardware
2. Builders Hardware Manufacturers Association (BHMA) Publications:
 - a. 1201- Auxiliary Hardware
 - b. 1301 - Materials and Finishes
3. Door and Hardware Institute (DHI) Publications:
 - a. Keying - Procedures, Systems, and Nomenclature
 - b. Abbreviations and Symbols
 - c. Hardware for Labeled Fire Doors
 - d. Recommended Locations for Builder's Hardware for Standard and Custom Steel Doors and Frames
 - e. Wood Door Standards W1, W2, WDHS-2 WDHS-3
4. National Fire Protection Association (NFPA) Publications:
 - a. NFPA Pamphlet No. 80 - Standards for Fire Doors and Windows.
 - b. NFPA Pamphlet No. 101.
5. International Building Code - 2009 Edition.
6. Americans with Disabilities Act (ADA).
7. ANSI A117.1

1.5 Deliveries, Storage and Handling

- A. Package each hardware item in separate containers with all screws, wrenches, installation instructions and installation templates. Mark each box with hardware heading and door number according to approved hardware schedule.
- B. Deliver individually packaged hardware items at the proper times to the proper locations (shop or project site) for installation: Provide a complete packing list showing items, door numbers and hardware headings with each shipment.
- C. Store hardware in shipping cartons above ground and under cover to prevent damage. Provide secure lockup for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable -so that completion of the Work will not be delayed by hardware losses both before and after installation.
- D. Aluminum Door Hardware: Deliver hardware for aluminum doors as directed by the door supplier.

1.6 Coordination

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

- B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
- D. Coordinate quantity and arrangement of assemblies with ceiling space configuration and with components occupying ceiling space, including structural members, pipes, air-distribution components, raceways, cable trays, recessed lighting fixtures, and other items.
- E. Access Control System Electrical Coordination: Coordinate the layout and installation of scheduled electrified door hardware, and related access control equipment, with required connections to source power junction boxes, power supplies, detection and monitoring hardware and fire alarm system.

1.7 Scope of Work

- A. Furnish and install at the indicated locations the specified electrified and integrated door hardware and access control firmware and software for a completely operational access control system. System includes, but is not necessarily limited, to the following:
 - 1. Electrified integrated card reader locks and exit hardware, door position switches, remote card readers, keypads, access cards and credentials, system application software, special tools, operating manuals, and required cabling and accessories as detailed below and listed in the Hardware Sets at the end of Part 3.

PART 2 - PRODUCTS

2.1 Hardware – General

- A. Provide the materials or products indicated by trade names, manufacturer's name, or catalog number. Substitutions will not be permitted except as described in Section 01630.
- B. Provide manufacturer's standard products meeting the design intent of this Specification, free of imperfections affecting appearance or serviceability.
 - 1. Provide hardware complete with all fasteners, anchors, instructions, layout templates, and any specialized tools as required for satisfactory installation and adjustment.
 - 2. Hand of door: Drawings show direction of slide, swing or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown
 - 3. Furnish screws for installation, with each hardware item. Provide Phillips flat-head screws except as otherwise indicated or approved. Finish screws exposed under any condition to match hardware finish or, if exposed in surfaces of other work, to match finish of such other work as closely as possible. Use machine screws for metal connections and wood screws for connections to wood. Use manufacturer's screws to secure hardware.
 - 4. Provide concealed fasteners for hardware units which are exposed when door is closed, except to extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt, head or nut on opposite face is exposed in other work, except where indicated otherwise or where it is not feasible to adequately reinforce the work. In such cases, provide sleeves for each thru-bolt or use sex screw fasteners.

5. Special Tools: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of finish hardware.
- C. Hardware is specified in the hardware schedule by set, type, and functions, which have been selected as best meeting the application requirements. Acceptable products for each category are specified in Paragraph 2.5, "Hardware Products".

2.2 Products

- A. Hinges:
 1. Manufacturers:
 - a. Scheduled Manufacturer: Ives.
 - b. Acceptable Manufacturers: Bommer, Hagar.
 2. Requirements:
 - a. Provide non-removable pins for all exterior doors and all interior out-swinging corridor doors. Use non-rising pins for all other doors.
 - b. Provide continuous hinge at exterior doors.
 - c. Provide heavy weight hinges.
 - d. Hinges shall be sized in accordance with the following:
 - Height: Doors up to 36" wide: 4-1/2" inches. Doors 36" to 48" wide: 5 inches.
 - Width: Sufficient to clear frame and trim when door swings 180 degrees.
 - Number of Hinges: Furnish 3 hinges per leaf to 7'-6" in height. Add one hinge for each additional 30 inches of height.
- B. Locksets:
 1. Manufacturers:
 - a. Scheduled Manufacturer: Schlage ND Series / Schlage L Series. - No substitution.
 2. Requirements:
 - a. All locksets to be grade 1 heavy duty cylindrical or mortise as specified.
 - b. Provide locks with standard 2-3/4 inches (70 mm) backset, unless noted otherwise, with 1/2 inch latch throw. Provide proper latch throw for UL listing at pairs.
 - c. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
 - d. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
 - e. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
 - f. Provide electrified options as scheduled in the hardware sets.
 - g. Provide lead lined locksets where specified.
- C. Exit Devices:
 1. Manufacturers:

- a. Scheduled Manufacturer: Von Duprin 98/99 Series. - No substitution.
- 2. Requirements:
 - a. All latchbolts to be deadlatching type.
 - b. All touchbars to be stainless steel. Touchpad to extend minimum one half of the door width. Provide exit devices with flush and tapered endcap.
 - c. Where lever handles are specified as outside trim for exit devices, provide heavy-duty lever trims with forged or cast escutcheon plates. Provide vandal-resistant levers that will travel to 90-degree down position when more than 35 pounds of torque are applied, and which can easily be re-set.
 - d. Provide UL labeled fire exit hardware for fire rated openings.
 - e. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion that is removed by use of a keyed cylinder, which is self-locking when re-installed.
 - f. Concealed vertical cable devices shall be provided on exterior doors without mullions. Device to have top and bottom latch that operate independently of each other.
 - g. Provide electrified options as scheduled in the hardware sets. Electronic latch retraction shall be quiet motorized design rather than solenoid driven.
- D. Closers:
 - 1. Manufacturers:
 - a. Scheduled Manufacturer: LCN – 4050 Series. - No Substitution.
 - 2. Requirements:
 - a. Comply with manufacturer's recommendations for unit size based on door size, weather exposure and usage.
 - b. Provide parallel arms for all overhead closers, except as otherwise indicated.
 - c. All Closers UL Certified to be in compliance with UBC 7.2 and UL 10C.
 - d. Closers with Pressure Relief Values will not be acceptable.
 - e. Provide any brackets or plates required for proper installation of door closers.
 - f. Closer cylinders, arms, adapter plates, and metal covers shall have a powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI Standard A156.4 and ASTM B117.
- E. Automatic Operators:
 - 1. Manufacturers:
 - a. Scheduled Manufacturer: LCN.
 - b. Acceptable Manufacturers: Horton, Record.
 - 2. Requirements:
 - a. Operation: Motor is off when door is in closing mode. Door can be manually operated with power on or off without damage to operator. Provide variable adjustments, including opening and closing speed adjustment.
 - b. Provide units with manual off/auto/hold-open switch, push and go function to activate power operator, vestibule interface delay, electric lock delay, hold-open delay

adjustable from 2 to 30 seconds, and logic terminal to interface with accessories and sensors.

- c. Provide drop plates, brackets, or adapters for arms as required to suit details.
- d. Provide hard-wired motion sensors and/or actuator switches for operation as specified.
- e. Provide key switches, with LED's, recommended and approved by manufacturer of automatic operator as required for function as described in operation description of hardware sets. Cylinders: Refer to "KEYING" article, herein.
- f. Provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer of automatic operator for each individual leaf. Actuators control both doors simultaneously at pairs. Locate actuators, key switches, and other controls as directed by Architect.

F. Door Trim

- 1. Manufacturers:
 - a. Scheduled Manufacturer: Ives.
 - b. Acceptable Manufacturers: Burns, Rockwood.
- 2. Requirements:
 - a. Provide pulls of solid bar stock, diameter and length as scheduled. Where thru-bolted provide decorative fastener.
 - b. Provide pull plates 4 inches (102 mm) wide by 16 inches (406 mm) high by 0.050 inch (1 mm) thick, beveled 4 edges, and prepped for pull. Where width of door stile prevents use of 4 inches (102 mm) wide plate, adjust width to fit.

G. Protection Plates

- 1. Manufacturers:
 - a. Scheduled Manufacturer: Ives.
 - b. Acceptable Manufacturers: Burns, Rockwood.
- 2. Requirements:
 - a. Provide kick plates, mop plates, and armor plates minimum of 0.050 inch (1 mm) thick as scheduled. Plates shall be beveled 4 edges with countersunk screws. Furnish with sheet metal or wood screws, finished to match plates.
 - b. Kick Plates: 10 inches high by 2 inches less width of door on single doors, 1 inch less width of door on pairs.
 - c. Armor Plates: 34 inches high by 2 inches less width of door on single doors, 1 inch less width of door on pairs. Provide UL labeled armor plates.

H. Overhead Stops and Holders

- 1. Manufacturers:
 - a. Scheduled Manufacturers: Glynn-Johnson
 - b. Acceptable Manufacturers: Rixson, ABH
- 2. Requirements:

- a. Provide heavy or medium duty and concealed or surface mounted overhead stop or holder for interior doors as specified. Provide medium duty surface mounted overhead stop for interior doors and at any door that swings more than 140 degrees before striking wall, open against equipment, casework, sidelights, and where conditions do not allow wall stop or floor stop presents tripping hazard.
- I. Door Stops and Holders
 - 1. Manufacturers:
 - a. Scheduled Manufacturer: Ives.
 - b. Acceptable Manufacturers: Burns, Rockwood.
 - 2. Provide door stops at each door leaf:
 - 3. Provide wall stops wherever possible. Provide concave type where cylindrical type locks are used.
 - 4. Where a wall stop cannot be used, provide overhead stop..
- J. Thresholds, Seals, and Gasketing
 - 1. Manufacturers:
 - a. Scheduled Manufacturer: Zero.
 - b. Acceptable Manufacturers: NGP, Reese.
 - 2. Requirements:
 - a. Provide thresholds, weatherstripping (including door sweeps, seals, astragals) and gasketing systems (including smoke, sound, and light) as specified and per architectural details. Match finish of other items.
 - b. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
 - c. Provide intumescent seal where required by door/frame manufacturer.
- K. Silencers
 - 1. Manufacturers:
 - a. Scheduled Manufacturer: Ives.
 - b. Acceptable Manufacturers: Burns, Rockwood.
 - 2. Requirements:
 - a. Provide "push-in" type silencers for hollow metal or wood frames.
 - b. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
 - c. Omit where gasketing is specified.
- L. Magnetic Holders
 - 1. Manufacturers:
 - a. Scheduled Manufacturer: LCN.
 - b. Acceptable Manufacturers: Rixson, Sargent.
 - 2. Requirements:

- a. Provide wall or floor mounted electromagnetic door release as specified with minimum of 25 pounds of holding force. Coordination projection of holder and armature with other hardware and wall conditions to ensure that door sits parallel to wall when fully open. Wire magnetic holders on fire-rated doors into the fire control panel for fail-safe operation.

2.3 Keying

- A. Cylinders to Schlage Everest to match Owner's existing system.
- B. Furnish cylinders in Small Format Interchangeable Core (SFIC). Pack change keys independently (PKI).
- C. Construction Cores Provide temporary construction cores for all openings.
- D. Key all locks separately, or alike, as directed by the Owner's representative and Architect. Keying schedule must be approved by Owner prior to ordering permanent cores.
- E. Copies of final key schedule with the bitting instructions shall be submitted as part of the Project Record Documents.
- F. Provide keys as follows:
 1. Change keys: 2 per lock.
 2. Master keys: 6 required (per system).
 3. Permanent Control Keys: 3.
 4. Construction Master Keys: 10.
- G. Identification: Stamp all (master-type) keys with the following:
 1. "Do Not Duplicate".
 2. Key change number (all keys).

2.4 Key Control System

- A. Key Control System Manufacturers:
 1. Scheduled Manufacturer: Telkee
 2. Acceptable Manufacturers: HPC, Lund
- B. Requirements:
 1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.
 2. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
 3. Provide hinged-panel type cabinet for wall mounting.

2.5 Wiring, Cable, and Connectors

- A. Connectors: Where scheduled in the hardware sets, provide each item of electrified hardware and wire harnesses with sufficient number and wire gauge with standardized Molex plug connectors to accommodate electric function of specified hardware. Provide Molex connectors that plug directly into connectors from harnesses, electric locking and power transfer devices. Provide through-door wire harness for each electrified locking device installed in a door and wire harness for each electrified hinge, electrified continuous hinge, electrified pivot, and electric power transfer for connection to power supplies.
- B. Provide and Install appropriate number of conductor pairs, in the wire gage (AWG) recommended by manufacturer, corresponding to the electronic locking functions specified, amperage drawn and distances covered between the power supplies, power transfer devices, electrified hardware and access control equipment.

2.6 Hardware Finishes

- A. Provide matching finishes for hardware units at each door to the greatest extent possible, unless otherwise indicated. In general, match items to the finish for the latch, lock or push pull unit for color and texture.
- B. Hardware finishes as follows:
 - 1. 626 - Satin Chrome-plated.
 - 2. 630 – Satin Stainless Steel

PART 3 - EXECUTION

3.1 Preparation

- A. Carefully inspect doors, and conditions under which hardware will be installed. Notify the Architect of any conditions that would adversely affect the installation or subsequent door operation. Do not proceed until unsatisfactory conditions are corrected.
- B. Prior to hardware installation, the General Contractor shall setup a meeting with the Hardware Supplier and the Hardware installer to ensure the installer has and understands the manufacturer's installation requirements for all hardware items.
- C. The Supplier shall observe the installation of the first lockset, closer, and exit device.

3.2 Installation

- A. Mount Hardware units at heights indicated in respective DHI Standards, except as specifically indicated, or required to comply with governing regulations, and except as may be otherwise directed by the Architect.
- B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces, which are later to be field, finished, coordinate removal, storage and reinstallation or application of surface protections with finishing work. Do not install surface-mounted items until finishes have been completed on substrate.
- C. Set units level, plumb and true to line and location. Adjust and reinforce the attachments substrate as necessary for proper installation and operation.

- D. Provide fasteners and anchoring devices of suitable size, quantity and type to secure hardware in proper position for heavy use and long life.
 - 1. Drill and countersink unit, which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards
- E. Adjust door closers immediately upon installation. Adjust in exact conformance with manufacturer's printed instructions. Advance backcheck to eliminate shock at dead stop. Set closer latching speed to assure unassisted positive latching.
 - 1. Degree of swing of door for self-limiting closers shall be maximum available.
- F. Adjust all exit devices immediately upon installation. Adjust in exact conformance with manufacturers' printed instructions.
- G. Install each protection plate with a thinly spread of mastic at its center to assure even contact before fastening with screws. Install all such plates on visual center of closed doors. Set bottom edges of all such plates flush with door bottom.
- H. Seal weather protection components attached to the exterior sides of doors and frames, such as drip caps and weather-stripping, in place with clear silicone caulk in such a manner as to ensure a continuously filled seam throughout the joinery.
- I. Cut and fit weatherstripping accurately to provide the greatest possible continuity of the contact element. Adjust closer template as required.

3.3 Adjust and Clean

- A. Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Replace units, which cannot be adjusted to operate freely and smoothly as intended for the applications made.
- B. Clean adjacent surfaces soiled by hardware installation
- C. Final Adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

3.4 Instructions and Inspection

- A. Instruct Owner's Personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.
- B. After hardware is installed and adjusted, the Supplier shall inspect the job with the Architect and the General contractor to determine if the hardware is functioning properly.
 - 1. Maintain the instruction sheets, layout templates, and any supplementary literature regarding hardware in a readable condition. Transmit all such items to the Owner's Representative, together with all spare parts, specialized tools, other accessories supplied with the hardware, and a copy of the approved hardware schedule at the time of instruction.

HARDWARE SCHEDULE

HARDWARE SET: 01

DOOR NUMBER:

1511

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	LD-RX-99-EO-ALK (HARDWIRED)	626	VON
1	EA	MORTISE CYLINDER	20-061 ICX	626	SCH
1	EA	SURFACE CLOSER	4050 SCUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	GASKETING	429AA-S	AA	ZER
1	EA	DOOR SWEEP	8197AA	AA	ZER
1	EA	THRESHOLD	65A-223	A	ZER
2	EA	WIRE HARNESS	CON (VERIFY LENGTH REQUIRED)		SCH
1	EA	DOOR CONTACT	679-05	WHT	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. NO ENTRY FROM EXTERIOR. WHEN PUSHBAR IS DEPRESSED ALARM WILL SOUND. DEVICE CAN BE ARMED, DISARMED, OR RESET AT OPENING VIA KEY. ALWAYS FREE EGRESS.

HARDWARE SET: 02

DOOR NUMBER:

1416

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	CONT. HINGE	112XY	628	IVE
1	EA	STOREROOM LOCK	ND80PD RHO	626	SCH
1	EA	SURFACE CLOSER	4050 SCUSH	689	LCN
1	EA	PA MOUNTING PLATE	4050-18PA (AS REQUIRED)	689	LCN
1	EA	CUSH SHOE SUPPORT	4050-30	689	LCN
1	EA	BLADE STOP SPACER	4050-61	689	LCN
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	DOOR SWEEP	8197AA	AA	ZER
1	EA	THRESHOLD	65A-223	A	ZER
1	EA	WEATHERSTRIP/ASTRAGAL BY DOOR/FRAME MANUFACTURER			

HARDWARE SET: 03

DOOR NUMBER:

1502 1524

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
2	EA	FIRE EXIT HARDWARE	9927-EO-F-LBR-499F	626	VON
2	EA	SURFACE CLOSER	4050 EDA	689	LCN
2	EA	ARMOR PLATE	8402 34" X 2" LDW B-CS	630	IVE
2	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	MAGNET	SEM7850 12V/24V/120V	689	LCN
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL SET	8193AA	AA	ZER

HARDWARE SET: 04

DOOR NUMBER:

1602

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
2	EA	POWER TRANSFER	EPT10 CON	689	VON
2	EA	ELEC PANIC HARDWARE	RX-QEL-9927-EO-LBR-CON 24 VDC	626	VON
1	EA	DELAYED EGRESS MAG	M490DEP 12/24 VDC	628	SCE
1	EA	MAGNETIC LOCK	M490P 12/24 VDC	628	SCE
1	EA	SURF. AUTO OPERATOR	9563 REG/STD MS AS REQ	ANCLR	LCN
2	EA	ARMOR PLATE	8402 34" X 1" LDW B-CS	630	IVE
2	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL SEAL	8217SBK PSA	BK	ZER
4	EA	WIRE HARNESS	CON (VERIFY LENGTH REQUIRED)		SCH
1	EA	POWER SUPPLY	PS904 900-4RL 120/240 VAC	LGR	SCE
2	EA	CARD READER	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: CORR ED1602 SIDE - DOOR NORMALLY CLOSED LOCKED ACCESS VIA VALID CARD READ WHICH UNLOCKS AND OPENS DOOR. ICU SIDE - VALID CARD READ TEMPORARILY DISABLES DELAYED EGRESS DEVICE ALLOWING EXIT AND OPENING DOOR. WITHOUT VALID CARD READ ALARM WILL SOUND WHEN PUSH PAD IS DEPRESSED, THE DEVICE WILL PREVENT EGRESS FOR 15 SECONDS OR LESS. DEVICE WILL DISARM IMMEDIATELY UPON FIRE ALARM.

HARDWARE SET: 05

DOOR NUMBER:

1523

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	ND80PD RHO	626	SCH
1	EA	ELECTRIC STRIKE	6211 FSE CON	630	VON
1	EA	SURFACE CLOSER	4050 RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	WIRE HARNESS	CON (VERIFY LENGTH REQUIRED)		SCH
1	EA	DOOR CONTACT	679-05	WHT	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC	WHT	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE
1	EA	CARD READER	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY VIA VALID CARD READ. ALWAYS FREE FOR EGRESS.

HARDWARE SET: 06

DOOR NUMBER:

1533

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	ND80PD RHO	626	SCH
1	EA	ELECTRIC STRIKE	6211 FSE CON	630	VON
1	EA	OH STOP	90S	630	GLY
1	EA	SURFACE CLOSER	4050 RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	WIRE HARNESS	CON (VERIFY LENGTH REQUIRED)		SCH
1	EA	DOOR CONTACT	679-05	WHT	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC	WHT	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE
1	EA	CARD READER	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY VIA VALID CARD READ. ALWAYS FREE FOR EGRESS.

HARDWARE SET: 07

DOOR NUMBER:

1409 1504

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	ND80PD RHO	626	SCH
1	EA	SURFACE CLOSER	4050 RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE SET: 08

DOOR NUMBER:

1425

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	ND80PD RHO	626	SCH
1	EA	OH STOP	90S	630	GLY
1	EA	SURFACE CLOSER	4050 RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE SET: 09

DOOR NUMBER:

1528

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	CLASSROOM LOCK	ND70PD RHO	626	SCH
1	EA	SURFACE CLOSER	4050 RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE SET: 10

DOOR NUMBER:

1503

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	CLASSROOM LOCK	ND70PD RHO	626	SCH
1	EA	SURFACE CLOSER	4050 EDA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE SET: 11

DOOR NUMBER:

1505 1506 1537 1609

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	ENTRANCE/OFFICE LOCK	ND50PD RHO	626	SCH
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE SET: 12

DOOR NUMBER:

1509 1513 1515 1518 1521 1527
1531 1535 1536

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	PIVOT SET	7255 SET	626	IVE
1	EA	PRIVACY LOCK	ND40S RHO	626	SCH
1	EA	RESCUE STRIKE	455 5-3/4	26D	HAG
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	MEETING STILE	8136 6" (152MM) PSA (APPLY AT GAP CREATED BY LOCK/STRIKE)		ZER
2	EA	MEETING STILE	398V	V	ZER

HARDWARE SET: 13

DOOR NUMBER:

1507 1508

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	PASSAGE SET	ND10S RHO	626	SCH
1	EA	SURFACE CLOSER	4050 RW/PA (4050 CUSH AT 1508)	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE SET: 14

DOOR NUMBER:

1532

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	PUSH PLATE	8200 6" X 16"	630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16"	630	IVE
1	EA	SURFACE CLOSER	4050 RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE SET: 15

DOOR NUMBER:

1510 1512 1514 1517 1520 1526
1530 1534

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	CONST LATCHING BOLT	FB51T	630	IVE
1	EA	PASSAGE SET	ND10S RHO	626	SCH
2	EA	OH STOP	90S J	630	GLY
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL SET	8193AA	AA	ZER

END OF SECTION

**SECTION 08 80 00
GLAZING**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Glass types including the following:
 - 1. Monolithic glass.
 - 2. Laminated glass units.
 - 3. Insulating glass units without solar control coatings.
 - 4. Radiation Shielding Glass

1.03 RELATED SECTIONS

- A. Section 08 11 13 - Hollow Metal Doors and Frames
- B. Section 08 14 16 - Flush Wood Veneer Doors
- C. Section 08 41 23 - Fire-Rated Aluminum Framed Entrances and Storefronts
- D. Section 08 41 25 - Fire-Rated Steel Entrances and Framing Systems
- E. Section 08 81 17 - Fire-Rated Glass

1.04 REFERENCES

- A. ANSI Z97.1: Standard for Safety Glazing Materials Used in Buildings
- B. CPSC 16 CFR 1201: Safety Standard for Architectural Glazing Materials
- C. GANA - Glazing Manual.
- D. FGMA - Sealant Manual.

1.05 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Design glass, including comprehensive engineering analysis according to ICC's 2015 International Building Code by a qualified professional engineer, using the following design criteria:
 - 1. Design Wind Pressures, Indoors Only: 5 pounds.
 - 2. Design Wind Pressures, Exterior: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
 - a. Wind Design Data: As indicated on Drawings.
 - b. Basic Wind Speed: 120 mph.
 - c. Importance Factor: 1.0.
 - d. Exposure Category: C.
 - 3. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
 - 4. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
 - 5. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

01-17-2022

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.06 SUBMITTALS

- A. Samples: Submit 12-inch by 12-inches (305mm by 305mm) samples of each type of glass indicated, except for clear monolithic glass products.
- B. Test and Evaluation Reports: Glazing contractor shall obtain compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials were tested for compatibility and adhesion with glazing sealant as well as other glazing materials including insulating units.
- C. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Product Data: Manufacturer's data sheets for each product specified, including but not limited to:
 1. Performance characteristics.
 2. Preparation instructions and recommendations.
 3. Storage and handling requirements and recommendations.
 4. Installation methods.
 5. Cleaning methods.
- E. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.07 QUALITY ASSURANCE

- A. Source Limitations for Glass: Obtain tinted float glass, coated float glass, insulated glass, laminated glass and clear glass from single source from single manufacturer for each glass type.
- B. Qualifications:
 1. Manufacturers: Fabrication processes, including low emissivity and reflective coatings, insulating, laminated, silk-screening and tempering shall be manufactured by a single manufacturer with a minimum of ten (10) years of fabrication experience and meet ANSI / ASQC 9002 1994.
 2. Fabricator's Qualifications: Certified by AGC Glass Company to fabricate solar control coated glass products.
 - a. Minimum of 5 years experience manufacturing sealed insulating glass units meeting ASTM E 2190.
 - b. Minimum of 5 years experience manufacturing laminated glass units meeting ASTM C 1172 and CPSC 16 CFR-1201.
- C. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.09 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when

01-17-2022

glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

1.10 SEQUENCING AND SCHEDULING

- A. Conference: Convene a pre-installation conference to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work.

1.11 WARRANTY

- A. Manufacturer's Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
 1. Warranty Period: 10 years from Date of Substantial Completion.
- B. Manufacturer's Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 1. Warranty Period: 10 years from Date of Substantial Completion.
- C. Manufacturer's Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 1. Warranty Period: 10 years from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Specified Manufacture: AGC Glass Company; North America.
 1. Contacts: P: 800-251-0441; Email: info@us.agc.com; Web: www.agcglass.com
- B. Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be acceptable.
 1. Viracon
 2. Insulite Glass Company.
 3. AGC Glass North America, Inc.
 4. Cardinal Glass Industries.
 5. Oldcastle.
 6. Guardian Glass, LLC.
 7. Vitro Architectural Glass.
- C. Radiation Shielding Glass:
 1. Corning Inc; Med-X.
 2. SCHOTT North America Inc.

2.02 PERFORMANCE REQUIREMENTS

- A. Provide glazing systems capable of withstanding normal thermal movements, wind loads and impact loads, without failure, including loss due to defective manufacture, fabrication and installation; deterioration of glazing materials; and other defects in construction.
- B. Safety Glazing: Where safety glazing is indicated, comply with testing requirements in 16 CFR 1201 for Category II materials.

- C. Delegated Design: Design glass installed adjacent to walking surfaces, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. Differential deflection of adjacent unsupported edges shall not exceed glass thickness when subjected to 50 lbf/ft (730 n/m) applied horizontally to one panel at any point up to 42 inches (1067 mm) above the adjacent walking surface.
 - 2. Base design on thickness at thinnest part of the glass.

2.03 GLASS PRODUCTS

- A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
- B. Glass Strength:
 - 1. Where float glass is indicated, provide annealed float glass, Kind HS heat strengthened float glass, or Kind FT fully tempered treated float glass as needed to comply with requirements indicated.
 - 2. Where heat treated glass is indicated, provide Kind HS heat strengthened float glass or Kind FT fully tempered float glass as needed to comply with requirements indicated.
 - 3. Where fully tempered glass is indicated, provide Kind FT fully tempered float glass.
- C. Heat-Treated Float Glass: ASTM C 1048, ASTM C 1036; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

2.04 LAMINATED GLASS

- A. Laminated Glass shall comply with ASTM C1172, and with testing requirements in 16 CFR 1201 and ANSI Z97.1 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
 - 1. Construction: Laminate glass with polyvinyl butyral (PVB) interlayer to comply with interlayer manufacturer's written recommendations.
 - 2. Polyvinyl Butyral (PVB) Interlayer:
 - a. Product:
 - 1) Viracon; "Vanceva® Color Interlay System".
 - b. Thickness: 0.060 inch (1.524 mm).
 - 1) Provide thickness not less than that indicated and as needed to comply with requirements.
 - c. Interlayer Color:
 - 1) Clear, unless otherwise indicated.
 - 2) Colored. Refer to "Glazing Types Schedule"
 - (a) Color/s to be selected from Manufacturer's standard colors.
 - (b) A single color can be selected or the base interlayers can be stacked to provide the specific color and opacity desired. Up to four interlayers* can be stacked between two plies of glass within a laminated glass unit.
 - (1) Coated glass requires a clear pvb interlayer between the coating and a colored interlayer.

2.05 INSULATING GLAZING UNITS

- A. Description: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, in accordance with ASTM E2190, and other requirements specified.
 - 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary.
 - 2. Metal Edge Spacers: Aluminum, bent and soldered corners.
 - a. Spacer Color: Anodized Aluminum.
 - 3. Desiccant: Molecular sieve or silica gel, or blend of both.
- B. Solar Control Insulating Vision Glazing Units - Assembly:
 - 1. Overall Unit Thickness: 1-inch (25mm) unless indicated otherwise.

2. Makeup:
 - a. Outboard Lite: Clear or Tinted float glass.
 - 1) Thickness: 1/4-inch unless otherwise indicated.
 - 2) Glass Type: Annealed (AN), Fully-Tempered (FT), or Heat-Strengthened (HS) Float Glass.
 - 3) Glass Coatings: Low-E (Surface 2), Reflective (Surface 2), or Uncoated.
 - b. Interspace: 1/2-inch clear air space with spacer.
 - c. Inboard Lite: Clear float glass.
 - 1) Thickness: 1/4-inch unless otherwise indicated.
 - 2) Glass Types: Annealed (AN), Fully-Tempered (FT), or Heat-Strengthened (HS).
 3. Provide safety glazing labeling where necessary.
- C. Laminated Solar Control Insulating Vision Glazing Units - Assembly:
1. Overall Unit Thickness: 1-5/16 inches (34 mm) unless indicated otherwise.
 2. Makeup:
 - a. Outboard Lite: Clear or Tinted Float Glass.
 - 1) Thickness: 1/4-inch unless otherwise indicated.
 - 2) Glass Type: Annealed (AN), Fully-Tempered (FT), or Heat-Strengthened (HS).
 - 3) Glass Coatings: Low-E (Surface 2), Reflective (Surface 2), or Uncoated.
 - b. Interspace: 1/2-inch clear air space with spacer.
 - c. Inboard Lite: Clear, Laminated (LAM) Float Glass, 2 Plies
 - 1) Glass Thickness: Each Ply: 1/4-inch.
 - 2) Glass Types: Annealed (AN), Fully-Tempered (FT), or Heat-Strengthened (HS).
 - 3) PVB Interlayer: 0.060-inch thickness.
 3. Provide safety glazing labeling where necessary.

2.06 COATED VISION GLASS (LOW-E)

- A. Product: AGC; "Energy Select 28, High-Performance; Triple-Silver Low-E Coated Glass.
 1. Substrate: 1/4-inch thick clear glass.
 2. Coating Position: Surface 2.
 3. Color: Neutral.
- B. Performance Characteristics: Based on 1-inch (6mm) insulating glazing unit assembly described in Heading 2.06 this Section.
 1. Transmittance (%):
 - a. Visible Light Transmittance (VLT): 62-percent.
 - b. Solar Transmittance: 24-percent.
 - c. UV Transmittance: 15-percent.
 2. Visible Light Reflectance (%): Out: 13-percent; In: 14-percent; Solar: 41-percent.
 3. Winter U-value (Imperial): 0.29 (Air).
 4. Shading Coefficient (SC): 0.32.
 5. Solar Heat Gain Coefficient (SHGC): 0.28.
 6. Light to Solar Gain (LSG): 2.18.
 7. DW Index: 0.47.

2.07 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
 1. Neoprene complying with ASTM C864.
 2. EPDM complying with ASTM C864.
 3. Silicone complying with ASTM C1115.
 4. Thermoplastic polyolefin rubber complying with ASTM C1115.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene EPDM silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.

01-17-2022

1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.
- C. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock-strips, complying with ASTM C 542, black.

2.08 GLAZING SEALANTS

- A. General:
 1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. Sealants used inside the weatherproofing system, shall have a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 4. Colors of Exposed Glazing Sealants: Clear.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class 50, Use NT.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Corning Corporation; 795.
 - b. GE Advanced Materials - Silicones; SilPruf SCS2000.
 - c. Sika Corporation, Construction Products Division; SikaSil-C995.
 - d. Tremco Incorporated; Spectrem 2.
 2. Applications: All Glass interior walls.

2.09 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
 1. AAMA 804.3 tape, where indicated.
 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.10 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.11 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.

2.12 SCHEDULE - GLAZING TYPES

- A. Glazing Types, as scheduled on the Drawings as Type 'GL-XX'.
- B. Abbreviations:
 - 1. AN - Annealed.
 - 2. HS - Heat Strengthened.
 - 3. FT - Fully Tempered.
 - 4. LAM - Laminated.
 - 5. STC - Sound Transmission Coefficient.
 - 6. PVB - Polyvinyl Butyral.
- C. GLAZING TYPE GL-1: FLOAT GLASS:
 - 1. Glass Type: 1/4-inch clear, AN Float Glass.
 - 2. Applications:
 - a. Interior glazing unless otherwise indicated.
- D. GLAZING TYPE GL-2: SAFETY GLAZING:
 - 1. Glass Type: 1/4-inch clear, FT Safety Glass.
 - 2. Applications:
 - a. Glazed lites in non-rated and 20-minute interior doors.
 - b. Glazed sidelight panels located next to doors
 - c. Glazed lites in partitions, except in fire-rated walls and partitions.
 - d. Other locations required by applicable federal, state, and local codes and regulations.
 - e. Other locations indicated on drawings.
- E. GLAZING TYPE GL-3: SECURITY GLAZING:
 - 1. Thickness: 9/16-inch.
 - 2. Glass Type: Clear, LAM.
 - a. Makeup: Two (2) layers of 1/8-inch clear, AN float glass with a 0.060-inch PVB interlayer between glass.
 - 1) Interlayer: Clear.
 - 3. Applications:
 - a. At locations indicated on drawings.
- F. GLAZING TYPE GL-11: LOW-E COATED INSULATING GLAZING, ANNEALED GLASS:
 - 1. Overall Unit Thickness: 1-inch (25 mm).
 - 2. Makeup:
 - a. Outdoor Lite: 1/4-inch clear, AN, with Low-E coating on Surface 2.

01-17-2022

- 1) Low-E Coating: AGC Energy Select 28, triple silver coated.
- b. Interspace: 1/2-inch clear air space with clear anodized spacer.
- c. Indoor Lite: 1/4-inch clear, AN.
3. Applications: Exterior window glass, except where required to be safety glass by Code.

G. GLAZING TYPE GL-12: LOW-E COATED INSULATING GLAZING, SAFETY GLASS:

1. Overall Unit Thickness: 1-inch (25 mm).
2. Makeup:
 - a. Outdoor Lite: 1/4-inch clear, FT glass with Low-E coating on Surface 2.
 - 1) Low-E Coating: AGC Energy Select 28, triple silver coated.
 - b. Interspace: 1/2-inch clear air space with clear anodized spacer.
 - c. Indoor Lite: 1/4-inch clear, FT glass..
3. Provide safety glazing labeling.
4. Applications:
 - a. Glazed lites in exterior doors.
 - b. Glazed sidelights and panels next to doors.
 - c. Other locations required by applicable federal, state, and local codes and regulations.
 - d. Other locations indicated on drawings.

H. GLAZING TYPE GL-14: LOW-E COATED INSULATING GLAZING, SECURITY GLASS:

1. Overall Unit Thickness: 1-5/16 inch.
2. Makeup:
 - a. Outdoor Lite (Tempered): 1/4-inch clear, FT glass with Low-E coating on Surface 2.
 - 1) Low-E Coating: AGC Energy Select 28, triple silver coated.
 - b. Interspace: 1/2-inch clear air space with clear anodized spacer.
 - c. Indoor Lite (Laminated): 9/16-inch clear, LAM glass (2-layers of 1/8-inch clear glass laminated together with a 0.060-inch PVB interlayer).
 - 1) Interlayer: Clear.
3. Provide safety glazing labeling.
4. Applications:
 - a. Glazed lites in exterior doors.
 - b. Glazed sidelights and panels next to doors.
 - c. Other locations required by applicable federal, state, and local codes and regulations.
 - d. Other locations indicated on drawings.

PZART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify prepared openings for glazing are correctly sized and within tolerance. Verify that the minimum required face and edge clearances are being followed.
 2. Verify that a functioning weep system is present.
 3. Do not proceed with glazing until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Immediately before glazing, clean glazing channels and other framing members receiving glass. Remove coatings not firmly bonded to substrates.
- B. Demolition / Removal: Remove and replace glass that is broken, chipped, cracked or damaged in any way.

3.03 INSTALLATION

- A. Install products using the recommendations of manufacturers of glass, sealants, gaskets and other glazing materials including those in the GANA Glazing Manual except where more stringent requirements are indicated.

- B. Prevent glass from contact with contaminating substances that result from construction operations such as weld splatter, fire-safing or plastering.

3.04 CLEANING

- A. Clean excess sealant or compound from glass and framing members immediately after application using solvents or cleaners recommended by manufacturers.

3.05 PROTECTION

- A. Protect glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
- D. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish Date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 08 80 00

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**SECTION 09 05 61
COMMON WORK RESULTS FOR FLOORING PREPARATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This section applies to floors identified in Contract Documents that are receiving the following types of floor coverings:

1.02 RELATED REQUIREMENTS

PART 2 PRODUCTS

PART 3 EXECUTION

END OF SECTION 09 05 61

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**SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Requirements for gypsum board assemblies.

1.03 RELATED SECTIONS:

- A. Section 06 10 00 - Rough Carpentry.
- B. Section 07 21 00 - Thermal Insulation.
- C. Section 07 92 00 - Joint Sealants.
- D. Section 13 49 13 - Integrated X-Ray Shielding Assemblies

1.04 ACTION SUBMITTALS

- A. Product Data: Provide data on gypsum board, accessories, and joint finishing system.
- B. Test Reports: For stud framing products that do not comply with ASTM C645 or ASTM C754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.

1.05 QUALITY ASSURANCE

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

1.06 DELIVERY, STORAGE AND HANDLING

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

1.07 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Specified Manufacture: USG Corporation.
 - 1. Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be acceptable.
 - a. CertainTeed Corp.
 - b. Georgia-Pacific Gypsum LLC.
 - c. National Gypsum Company.
 - d. Temple-Inland.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies (as applicable): For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies (as applicable): For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.03 GYPSUM BOARD, GENERAL

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

2.04 INTERIOR GYPSUM BOARD

- A. TYPE 'X' INTERIOR GYPSUM BOARD:
 - 1. Gypsum Board: ASTM C1396/C1396M, Type X.
 - 2. Product: USG; "Sheetrock® Brand EcoSmart Panels Firecode® X".
 - a. Composition: Noncombustible gypsum core encased in 100% recycled face and back papers.
 - b. Thickness: 5/8 inch.
 - c. Long Edges: Tapered.
 - 3. Physical Properties:
 - a. UL Type Designation: "ULIX".
 - b. ASTM E136: Non-combustibility: Meets or exceeds criteria.
 - c. ASTM E84: Surface-Burning Characteristics:
 - 1) Flame Spread: 5.
 - 2) Smoke Developed: 5.
 - d. Classified as a Class 'A' Interior Finish Material per Section 803.1 of the International Building Code.
 - e. ASTM C473:
 - 1) Core Hardness: Not less than 11.
 - 2) Flexural Strength (lbft).
 - (a) Parallel: Not less than 46.
 - (b) Perpendicular: Not less than 147.
 - 4. Uses:
 - a. Above 10'-0" a.f.f. where abuse-resistant gypsum board occurs on lower portion of wall.
 - b. Fire-rated wall construction.
 - c. Non-fire-rated wall construction.
- B. INTERIOR GYPSUM CEILING BOARD:
 - 1. Gypsum Board: ASTM C1396/C1396M, gypsum ceiling board.
 - 2. Product: USG; "Sheetrock® Brand Gypsum Panels".
 - a. Composition: Fire-resistant gypsum core encased in 100% recycled face and back papers.
 - b. Thickness: 1/2-inch.
 - c. Long Edges: Tapered.
 - 3. Physical Properties:
 - a. ASTM E84 Surface-Burning Characteristics:
 - 1) Flame Spread: 15.
 - 2) Smoke Developed: 0.
 - b. Classified as a Class 'A' Interior Finish Material per Section 803.1 of the International Building Code.
 - c. ASTM C473:
 - 1) Core Hardness: Not less than 11.

- 2) Flexural Strength (lbft).
 - (a) Parallel: Not less than 77.
 - (b) Perpendicular: Not less than 228.
- 4. Uses:
 - a. Non-fire-rated single-layer ceiling and soffit construction.

C. MOISTURE AND MOLD RESISTANT INTERIOR GYPSUM BOARD:

- 1. Gypsum Board: ASTM C1396/C1396M, Type X, water-resistant gypsum board.
- 2. Product: USG; Sheetrock® Brand EcoSmart Panels, Mold Tough® Firecode® X Panels".
 - a. Composition: Noncombustible, moisture- and mold-resistant gypsum core encased in moisture- and mold-resistant, 100% recycled green face and brown back papers.
 - b. Thickness: 5/8 inch.
 - c. Long Edges: Tapered.
- 3. Physical Properties:
- 4. UL Classification: Type "ULIX".
- 5. ASTM E136: Non-combustibility: Meets or exceeds criteria.
- 6. ASTM E84: Surface-Burning Characteristics:
 - a. Flame Spread: 5.
 - b. Smoke Developed: 5.
- 7. Classified as a Class 'A' Interior Finish Material per Section 803.1 of the International Building Code.
- 8. ASTM C473:
 - a. Core Hardness: Not less than 11.
 - b. Flexural Strength (lbft).
 - 1) Parallel: Not less than 46.
 - 2) Perpendicular: Not less than 147.
 - 3) The average water absorption for panels is not greater than 5% by weight after two-hour immersion.
 - c. ASTM D3273: Mold Resistance: A score of 10 as rated.
- 9. Uses:
 - a. As a substrate for tiling per Section 09 30 00 - Tiling.
 - b. Fire-rated partitions.
 - c. Non-fire-rated partitions.

D. ABUSE AND MOLD RESISTANT INTERIOR GYPSUM BOARD:

- 1. Abuse Resistant Gypsum Board: ASTM C1629/C1629M, Type X, water-resistant gypsum board.
- 2. Product: USG; "Sheetrock® Brand Mold Tough® AR Firecode® X Panels".
 - a. Composition: Noncombustible, moisture-resistant gypsum core encased in moisture- and mold-resistant, 100% recycled green face and brown back papers.
 - b. Thickness: 5/8 inch.
 - c. Long Edges: Tapered.
- 3. For abuse-resistant construction over steel framing, minimum 20-gauge drywall steel studs are required.
- 4. Physical Properties:
 - a. UL Classification: Type "AR".
 - b. ASTM E136: Non-combustibility: Meets or exceeds criteria.
 - c. ASTM E84: Surface-Burning Characteristics:
 - 1) Flame Spread: 15.
 - 2) Smoke Developed: 5.
 - d. Classified as a Class 'A' Interior Finish Material per Section 803.1 of the International Building Code.
 - e. ASTM C1629/C1629M:
 - 1) Abrasion Resistance; Level 2.

- 2) Indentation Resistance; Level 1.
- 3) Soft Body Impact Resistance; Level 2.
- 4) Hard Body Impact Resistance; Level 1.
- f. ASTM C473: The average water absorption for panels is not greater than 5% by weight after two-hour immersion
- g. ASTM D3273: Mold Resistance: A score of 10 as rated.
- 5. Uses:
 - a. As a substrate for tiling per Section 09 30 00 - Tiling.
 - b. Fire-rated partitions.
 - c. Non-fire-rated partitions.

E. INTERIOR GYPSUM LINER PANELS: ASTM C1396/C1396M,

- 1. Gypsum Liner Panel: ASTM C1396/C1396M, Type X, with moisture resistance.
- 2. Product: USG; Sheetrock® Brand Glass-Mat Liner Panels Mold Tough®.
 - a. Composition:
 - b. Thickness: 1 inch.
 - c. Long Edges: Double Beveled.
- 3. Physical Properties:
 - a. UL Classification: Type "SLX".
 - b. ASTM D3273 Mold Resistance: A score of 10 as rated according to ASTM D3273.
 - c. ASTM E136: Non-combustibility: Meets or exceeds criteria.
 - d. ASTM E84 Surface-Burning Characteristics:
 - 1) Flame Spread: 20.
 - 2) Smoke Developed: 0.
 - e. Classified as a Class 'A' Interior Finish Material per Section 803.1 of the International Building Code.
 - f. ASTM C473:
 - 1) Core Hardness: Not less than 11.
 - 2) Flexural Strength (lbft).
 - (a) Parallel: Not less than 77.
 - (b) Perpendicular: Not less than 228.
 - 3) ASTM D3273: Mold Resistance: A score of 10 as rated.
- 4. Uses:
 - a. Shaft wall liner panel.
 - 1) Fire Rating as indicated on drawings.

F. INTERIOR GLASS-MAT BACKERBOARD:

- 1. Glass-Mat Backerboard: ASTM C1178/C1178M.
- 2. Product: USG; "Durock™ Brand Glass-Mat Tile Backerboard"
- 3. Thickness: 5/8 inch.
- 4. Physical Properties:
 - a. Mold Resistance: ASTM D3273: Score of 10.
 - b. ASTM E84 Surface-Burning Characteristics:
 - 1) Flame Spread: 15.
 - 2) Smoke Developed: 5.
 - c. Permeability: ASTM E96/E96M: <1 perm.
- 5. Used behind porcelain and ceramic tile where indicated.
- 6. Fastener Requirements:
 - a. Screws for Fastening Backerboard to Metal Stud Framing: DUROCK Tile Backer Screws, 1-5/8 inches long.

G. LEAD-BACKED GYPSUM BOARD:

- 1. Refer to Section 13 49 13 - Integrated X-Ray Shielding Assemblies for requirements.

2.05 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.
 - 1. Material: Galvanized or rolled zinc.
 - 2. Shapes:
 - a. Corner Bead: USG Sheetrock® Brand Dur-A-Bead® Corner Bead.
 - 1) Optional: USG Sheetrock® Brand Paper-Faced Metal Corner Bead Outside Corner, Tape-On (B1XW-EL Series).
 - b. Bullnose Corner Bead: USG Sheetrock® Brand Paper-Faced Metal Corner Bead - 3/4" Bullnose Outside Corner, Tape-On (SLOC Series).
 - c. J-Trims: USG Sheetrock® Brand Paper-Faced Metal Trim, J-Shaped, Tape-On (B9 Series).
 - 1) Exposed long flange receives joint compound.
 - 2) Exposed short flange does not receive joint compound.
 - d. L-Trims: USG Sheetrock® Brand Paper-Faced Metal Trim, L-Shaped, Tape-On (B4 Series).
 - 1) Exposed long flange receives joint compound.
 - e. Reveal Trims: USG Sheetrock® Brand Paper-Faced Metal Trim Reveal, Tape-On (Reveal NB Series).

2.06 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
- C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.

2.07 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 - 1. Products: Subject to compliance with requirements, Refer to Section 07 92 00 - Joint Sealants:
 - 2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Thermal Insulation: Refer to Section 07 21 00.

PART 3 EXECUTION

3.01 EXAMINATION

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

01-17-2022

3.02 INSTALLATION - GENERAL

- A. Comply with ASTM C840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.
- F. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- G. STC-Rated Assemblies (if applicable): Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

3.03 INSTALLATION - GYPSUM BOARD

- A. Single-Layer Applications:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
 - 2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - 3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
 - 4. Fastening Methods: Apply gypsum panels to wood stud supports with wood screws.
- B. Multi-layer Applications:
 - 1. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 - 2. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.04 INSTALLATION - TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

01-17-2022

- B. Control Joints: Install control joints according to ASTM C840, as shown on the drawings or coordinated with the Architect prior to the start of work. Control joints shall be installed in face layer of the gypsum board at the following locations:
 - 1. Ceilings: Install control joints in ceilings at 50-foot intervals in either direction to limit areas to 2,500 SF. Control joints shall also be installed where ceiling framing changes direction.
 - 2. Walls: In long partition runs without full height breaks, control joints should be installed at 30'-0" intervals, from floor to ceiling.
 - 3. Doorways and other wall openings: Full height door frames or other full height breaks in the wall surface may be considered as control joints. Less than ceiling height frames should have control joints extending to the ceiling from both corners. Borrowed lite frames should have control joints extending to the floor and ceiling from both corners.
 - 4. Align ceiling and soffit gypsum joints with wall gypsum joints where possible.
- C. Interior Trim: Install with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions. All exposed edges of gypsum shall have trim. Install in the following locations:
 - 1. Cornerbead: Use at outside corners unless otherwise indicated.
 - 2. LC-Bead: Use where indicated.
 - 3. L-Bead: Use where indicated.
 - 4. U-Bead: Use where indicated.

3.05 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. LEVEL 1: Plenum areas above ceiling, and other areas where gypsum board may be concealed.
 - a. Finish requirements:
 - 1) All joints and angles shall have tape embedded in joint compound.
 - 2) Tape and fastener heads need not be covered with joint compound.
 - 3) Tool marks and ridges are acceptable.
 - 2. LEVEL 2: Panels that are substrate for tile.
 - a. Finish requirements:
 - 1) All joints and angles shall have tape embedded in joint compound.
 - 2) Joints shall be wiped with a joint knife, leaving a thin coating of joint compound over all joints and angles.
 - 3) Fastener heads and accessories shall be covered with one coat of joint compound.
 - 4) Tool marks and ridges are acceptable.
 - 3. LEVEL 3: Not Used.
 - 4. LEVEL 4:
 - a. At exposed panel surfaces where paint finishes are scheduled. Refer to the Interior Finish Legend for paint sheen callouts.
 - b. Finish requirements:
 - 1) All joints and angles shall have tape embedded in joint compound.
 - 2) Joints shall be wiped with a joint knife, leaving a thin coating of joint compound over all joints and angles. In addition, two separate coats of joint compound shall be applied over all flat joints, and one separate coat applied over all angles.
 - 3) Fastener heads and accessories shall be covered with three separate coats of joint compound.

- 4) Surface shall be smooth and free of tool marks and ridges.
- 5) The prepared surface shall be covered with drywall primer prior to the application of the final topcoats.

3.06 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 09 21 16

SECTION 09 22 16
NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Non-load-bearing steel framing systems for interior gypsum board assemblies.
- B. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

1.03 SUBMITTALS

- A. Shop Drawings:
 - 1. Indicate prefabricated work, component details, stud layout, framed openings, anchorage to structure, acoustic details, type and location of fasteners, accessories, and items of other related work.
 - 2. Describe method for securing studs to tracks, splicing, and for blocking and reinforcement of framing connections.
- B. Product Data: Provide data describing framing member materials and finish, product criteria, load charts, and limitations.
- C. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
- D. Provide sealed engineering calculations and designs as may be required for special framing conditions based on deflection limitations of L/240, 5 lbs/sq. ft. live load and dead load per location for painted finishes. Tile finishes shall have L/640 deflection limitations.

PART 2 PRODUCTS

2.01 DESCRIPTION

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.02 FRAMING SYSTEMS

- A. Fire Rated Assemblies: Comply with applicable code and as follows:
 - 1. Fire Rated Partitions: Listed assembly by UL, as shown on the drawings.
 - 2. Top of Fire Rated Partitions: Listed assembly by UL, as shown on the drawings.
 - 3. Fire Rated Ceiling and Soffits: Listed assembly by UL, as shown on the drawings.
 - 4. Fire Rated Structural Column Framing: Listed assembly by UL, as shown on the drawings.
 - 5. Fire Rated Structural Beam Framing: Listed assembly by UL, as shown on the drawings.
 - 6. Fire Rated Shaft Wall Requirements: Listed assembly by UL, as shown on the drawings.

2.03 MANUFACTURER

- A. Specified Manufacture: Clark Dietrich Building Systems.
 - 1. Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be accepted. Additional manufacturers will be considered in accordance with the "or equal" provision specified in Section 01 60 00 - Product Requirements.
 - a. CEMCO
 - b. MarinoWARE.
 - c. Simpson Strong Tie.
 - d. The Steel Network, Inc.

01-17-2022

2. Substitutions: Submit a request for substitution for any manufacturer not named, as specified in Section 01 25 00 - Substitution Procedures.

2.04 MATERIALS

- A. Framing Members, General: Comply with ASTM C754 for conditions indicated.
 1. Steel Sheet Components: Comply with ASTM C645 requirements for metal unless otherwise indicated.
 2. Protective Coating: ASTM A653/A653M, G60 (Z180), hot-dip galvanized, unless otherwise indicated.
- B. Studs and Runners: ASTM C645. Use either steel studs and runners or Pro steel studs and runners.
 1. Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm) 20-gauge for studs and runners at impact resistant gypsum board partitions, partitions indicated to receive ceramic tile, fire and smoke rated partitions, door jambs and at other indicated locations.
 - b. Depth: 3-5/8 inches, 6 inches, 2-1/2 inches, or 1-5/8 inches as indicated on drawings.
 2. Dimpled Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: 0.025 inch (0.64 mm) 25-gauge
 - b. Depth: 3-5/8 inches, 6 inches, 2-1/2 inches, or 1-5/8 inches as indicated on drawings.
- C. Slip-Type Head Joints: Where indicated, provide, allowing for 1" of movement, or other as indicated:
 1. Single Long-Leg Slotted Runner System: ASTM C645 top runner with 2-1/2-inch deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
- D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 1. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm) 20-gauge.
- E. Cold-Rolled Channel Bridging: Steel, 0.053-inch (1.34-mm) 16-gauge minimum base-metal thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
 1. Depth: 1-1/2 inches (38 mm).
- F. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch (1.72-mm) 14-gauge thick, galvanized steel.
- G. Hat-Shaped, Rigid Furring Channels: ASTM C645.
 1. Minimum Base-Metal Thickness: 0.018 inch (0.45 mm) 25-gauge
 2. Depth: 7/8 inch (22.2 mm).
- H. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-metal thickness of 0.018 inch (0.45 mm) 25 gauge, and depth required to fit insulation thickness indicated.

2.05 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- B. Hanger Attachments to Concrete:
 1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E488/E488M by an independent testing agency.
 - a. Type: Post-installed, expansion anchor.
 2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent

01-17-2022

testing agency.

- C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.
- D. Flat Hangers: Steel sheet, 1 by 3/16 inch (25 by 5 mm) by length indicated.
- E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch (1.34 mm) and minimum 1/2-inch- (13-mm-) wide flanges.
 - 1. Depth: 1-1/2 inches (38 mm).
- F. Furring Channels (Furring Members):
 - 1. Cold-Rolled Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
 - 2. Steel Studs and Runners: ASTM C645.
 - a. Minimum Base-Metal Thickness: As indicated on Drawings or determined by span and loading requirements.
 - b. Depth: As indicated on Drawings, 3-5/8 inches (92 mm) typical and others as needed by spans and loadings.
 - 3. Hat-Shaped, Rigid Furring Channels: ASTM C645, 7/8 inch (22 mm) deep.
 - a. Minimum Base-Metal Thickness: 0.018 inch (0.45 mm).
- G. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong World Industries, Inc.; Drywall Grid Systems.
 - b. Chicago Metallic Corporation; Drywall Grid System.
 - c. USG Corporation; Drywall Suspension System.

2.06 FABRICATION

- A. Fabricate assemblies of framed sections to sizes and profiles required.
- B. Fit, reinforce, and brace framing members to suit design requirements.
- C. Fit and assemble in largest practical sections for delivery to site, ready for installation.

2.07 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

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

3.03 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754, except comply with framing sizes and spacing indicated.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.

01-17-2022

- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.04 INSTALLING FRAMED ASSEMBLIES

- A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- B. Install studs so flanges within framing system point in same direction.
 - 1. Space studs as follows:
 - a. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
 - b. Multilayer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
 - c. Tile Backing Panels: 16 inches (406 mm) o.c. unless otherwise indicated.
- C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two 20 ga. studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- D. Direct Furring:
 - 1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
- E. Z-Furring Members:
 - 1. Erect insulation, specified in Section 07 21 00 "Thermal Insulation," vertically and hold in place with Z-furring members spaced 24 inches (610 mm) o.c.
 - 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
 - 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (305 mm) from corner and cut insulation to fit.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.05 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other

assembly components indicated.

- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards, minimum of 5 pounds per square foot uniform live load plus dead loads with L/360 deflection limit.
 - 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 5. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09 22 16

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**SECTION 09 51 00
ACOUSTICAL CEILINGS**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Suspended acoustical ceilings including the following:
 - 1. Acoustical panels (suspended).
 - 2. Exposed tee metal grid ceiling system and perimeter trim.
- B. Acoustical Suspended Panel Ceilings.

1.03 DESIGN / PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to IBC Section 1613 or ASCE/SEI 7.
 - 1. Occupancy (Risk) Category: II.
 - 2. Site Classification (1613.3.2): C.
 - 3. Seismic Design Category: B.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials, 25 or less.
 - 2. Smoke-Developed Index: 50 or less.

1.04 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00 - Submittal Procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Dimensions, load carrying capacity, and performance standards compliance.
 - 3. Storage and handling requirements and recommendations.
 - 4. Installation and maintenance instructions.
- C. Shop Drawings: Reflected ceiling plan indicating ceiling layouts, dimensions and perimeter conditions, and ceiling schedule including panel and grid types to match codes used on the Drawings. Indicate grid layouts and related dimensioning, junctions with other work or ceiling finishes, interrelation of mechanical and electrical items related to system. Indicate method of suspension where interference exists.
- D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each finish product specified, two samples, actual size of acoustical units, and two samples minimum size 12 inches (300 mm) long of main tees and cross tees square, representing actual product, color, finish and patterns.
- F. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- G. Verification Samples: For each finish product specified, two samples, actual size of acoustical units, and two samples minimum size 12 inches (300 mm) long of main tees and cross tees square, representing actual product, color, finish and patterns.
- H. Closeout Submittals
 - 1. Maintenance Data: For finishes to include in maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

- B. Manufacturer member in good standing of Cisca (Ceiling and Interior Systems Construction Association)
- C. Installer Qualifications: Company specializing in performing Work of this section with minimum three years documented experience.
- D. Provide seismic design of suspended ceiling under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver acoustical tiles, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical tiles carefully to avoid chipping edges or damaging units in any way.

1.07 SEQUENCING

- A. Sequence Work to ensure acoustic ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities and wet work have terminated, and overhead work is completed, tested, and approved.
- B. Install acoustic units after interior wet work is dry.
- C. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.08 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.09 EXTRA MATERIALS

- A. Deliver extra acoustical units for Owner's use in maintenance. Label and store where directed by the Owner including codes used on the Drawings. Do not deliver to the Project site until the Owner is prepared to receive and store maintenance materials.
 - 1. Ceiling Panels: For each type specified, provide full-size panels in unopened boxes equal to no less than 5 percent of quantity installed.

1.10 WARRANTY

- A. Acoustical Ceiling Systems:
 - 1. The manufacturer shall warrant the ceiling panels and suspension systems to be free from defects in materials or factory workmanship for thirty (30) years from Date of Substantial Completion, when installed together and used under normal conditions.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Acoustical Ceiling Systems:
 - 1. Specified Manufacturer: Armstrong World Industries, Inc.
 - a. Other Acceptable Manufacturer: None identified. No substitutions will be considered or accepted.

2.02 ACOUSTICAL CEILINGS

- A. Acoustical Ceiling Panels, scheduled on the Drawings as Finish Type ACT- #.
 - 1. Product/s: Refer to the "Interior Finish Legend" (Sheet A4.2) for pertinent information on this Finish Type.
- B. Acoustical Ceiling Panel Types:
- C. Physical Properties, General:

01-17-2022

1. Material: Wet-formed mineral fiber with factory-applied latex paint.
2. Performance:
 - a. Surface Burning Characteristics (ASTM E84): Flame Spread Index: 25 or less; Smoke Developed Index: 50 or less.
 - b. Fire Class (ASTM E1264): Class A.
- D. Acoustical Ceiling Panel, Type ACT-1:
 1. Manufacturer: As scheduled on drawings.
 2. Product: As scheduled on drawings.
 - a. Minimum Requirements: Comply with ASTM E1264, Type III, Form 1, Pattern C E.
 - b. Size: 24-inch by 24-inch by 7/8-inch.
 - c. Edges: Square.
 - d. Recycled Content: 73%.
 - e. Sag / Humidity Resistant.
 - f. Mold and Mildew Resistant.
 - g. Color: White.
 - h. Suspension System: Prelude XL 15/16" Exposed Tee.
 3. Acoustic Performance: CAC = 35, LR = 86%, NRC = 0.75, AC = 170.
- E. Suspension System:
 1. Product: Armstrong; Prelude XL 15/16" Exposed Tee, Direct-Hung, Double-Web Suspension System.
 2. Description: Main and cross runners roll formed from and capped with cold-rolled steel sheet, pre-painted white, electrolytically zinc coated, or hot-dip galvanized according to ASTM A653/A653M, G30 (Z90) coating designation.
 - a. Structural Classification: Intermediate-duty system.
 - b. Access: Upward
 - c. Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C635/C635M.
 - d. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 - 1) Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
 - 2) Size: Select wire diameter so its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire but provide not less than 0.106-inch (2.69-mm) diameter wire.
- F. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Manufacturer's standard moldings for edges and penetrations complying with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners, white.
 1. Provide manufacturer's standard edge moldings that fit acoustical tile edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
 2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

2.03 OTHER SUSPENDED CEILING SYSTEMS

- A. Specialty Ceiling Systems: Refer to Section 09 51 16.
 1. Acoustical Ceiling Baffles.
 2. Acoustical Clouds.
 3. Linear Acoustical Panels.
 4. Acoustical Metal Ceilings.
- B. Linear Metal Ceilings: Refer to Section 09 54 23.
- C. Suspended Wood Ceilings: Refer to Section 09 54 26 - Suspended Wood Ceilings

01-17-2022

2.04 ACOUSTICAL SEALANT

- A. Products: Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Acoustical Sealant for Concealed Joints:
 - a. Henkel Corporation; OSI Sealants Pro-Series SC-175 Rubber Base Sound Sealant.
 - b. Pecora Corporation; AIS-919.
 - c. Tremco, Inc.; Tremco Acoustical Sealant.
- B. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 - 1. Concealed Joints: Nondrying, non-hardening, non-skinning, non-staining, gunnable, synthetic-rubber sealant.

PART 1 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Verify layout of hangers will not interfere with other work.
- C. Verify acoustical unit layout conditions, which will adversely affect installation.
- D. If layout or substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- E. Verify wet work such as plastering and concrete is complete and dry. Verify building is enclosed and under standard occupancy conditions prior to start of installation.
- F. Commencement of installation constitutes Installer's acceptance of substrate conditions.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISC's "Ceiling Systems Handbook."
 - 1. Suspend ceiling hangers from building's structural members and as follows:
 - a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - b. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - c. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - d. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - e. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

- f. Fasten hangers to postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - g. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 - h. Attach hangers to structural members.
 - i. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
 - j. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
 - 2. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
 - 3. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical tiles.
 - a. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
 - b. Do not use exposed fasteners, including pop rivets, on moldings and trim.
 - 4. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
 - 5. Arrange directionally patterned acoustical ceiling panels and/or tiles as indicated on reflected ceiling plans
- B. Install acoustical ceiling tiles per manufacturer's requirements.

3.04 ERECTION TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.05 PROTECTION AND CLEANING

- A. Protect installed products until completion of project.
- B. Clean adjacent surfaces and remove unused materials and debris from site.
- C. Clean exposed surfaces in accordance with manufacturer's written instructions.
- D. Remove and reinstall improperly installed material.
- E. Remove damaged components, replace with undamaged components.
- F. Touch-up, repair or replace damaged units until satisfactory results are obtained.
- G. Clean with non-solvent based non-abrasive commercial cleaning solution.

END OF SECTION 09 51 00

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**SECTION 09 65 00
RESILIENT FLOORING**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Resilient sheet flooring.
- B. Luxury Vinyl Tile.
- C. Installation accessories.

1.03 RELATED SECTIONS

- A. Section 01 45 00 - Concrete In-Situ Relative Humidity and pH Testing
- B. Section 09 65 13 - Resilient Base and Accessories
- C. Section 03 30 00 - Cast-in-Place Concrete

1.04 REFERENCE STANDARDS

- A. AATCC Test Method 134 - Test Method for Electrostatic Propensity of Carpets 2019.
- B. ASTM D2047 - Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine 2017.
- C. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness 2015 (Reapproved 2021).
- D. ASTM E662 - Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials 2021a, with Editorial Revision.
- E. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source 2019a, with Editorial Revision (2020).
- F. ASTM F2055 - Standard Test Method for Size and Squareness of Resilient Floor Tile by Dial Gauge Method 2017 (Reapproved 2021).
- G. ASTM F925 - Standard Test Method for Resistance to Chemicals of Resilient Flooring 2013 (Reapproved 2020).
- H. ASTM F970 - Standard Test Method for Measuring Recovery Properties of Floor Coverings after Static Loading 2017.
- I. ASTM F1303 - Standard Specification for Sheet Vinyl Floor Covering with Backing 2004 (Reapproved 2021).
- J. ASTM F1344 - Standard Specification for Rubber Floor Tile 2021a.
- K. ASTM F1700 - Standard Specification for Solid Vinyl Floor Tile 2020.
- L. ASTM F1913 - Standard Specification for Vinyl Sheet Floor Covering Without Backing 2019.
- M. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source 2019.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.
- D. Verification Samples: Submit two samples, in size illustrating color and pattern for each resilient flooring product specified.

01-17-2022

- E. Concrete Testing Standard: Submit a copy of ASTM F710.
- F. Concrete Sub-floor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.
- G. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of sub-floor is acceptable.
- H. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in installing specified flooring with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
- B. Store all materials off of the floor in an acclimatized, weather-tight space.

1.08 FIELD CONDITIONS

- A. Maintain temperature and humidity at service levels or the ambient temperature must remain steady ($\pm 10^{\circ}\text{F}$) and be between 59°F and 80°F for at least 48-hours prior, during and 72-hours after installation. .) The ambient relative humidity is recommended to be $50\% \text{ RH} \pm 10\%$; however, dew point must be avoided.

1.09 EXTRA MATERIALS

- A. Deliver extra resilient flooring material for Owner's use in maintenance. Label and store where directed by the Owner including codes used on the Drawings. Do not deliver to the Project site until the Owner is prepared to receive and store maintenance materials.
 - 1. Luxury Vinyl Tile: For each type specified, provide full-size tiles in unopened boxes equal to no less than 3 percent of each type and color installed.

1.10 WARRANTY

- A. Refer to "Warranty" Articles for each material specified.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Specified Manufacturer: Refer to flooring types for manufacturer callouts.
 - 1. Other Acceptable Manufacturer: None identified. No substitutions will be considered or accepted.

2.02 RESILIENT SHEET FLOORING

- A. Resilient Sheet Flooring, as scheduled on the Drawings as Finish Type RSF-1, RSF-2, RSF-3, RSF-4, and RSF-5
 - 1. Product/s: Refer to the "Interior Finish Legend" (Sheet A4.5) for pertinent information on this Finish Type.
- B. Heterogeneous Vinyl Sheet Floor Covering: **
 - 1. Reference Specification: ASTM F1303, Type I, Grade 1, Class C Backing.
 - 2. Material: A multi-layered construction consisting of a clear vinyl wear layer and a printed, reinforced fiberglass inner layer on a solid vinyl backing. Protected by a UV-cured, high-performance diamond-infused polyurethane finish, the wear surface has an overall embossed texture.
 - 3. Physical Properties:
 - a. Overall Thickness (nom.): 0.080-inches (2.0 mm)
 - b. Wear Layer Thickness (nom.): 0.022-inches (0.55 mm)
 - c. Width: 6'-7" (2.0 m).

01-17-2022

4. Performance:
 - a. Fire Test Data:
 - 1) ASTM E648: Critical Radiant Flux: 0.45 watts/sq. cm, minimum: Class 1.
 - 2) ASTM E662: Smoke Density: 450 or less.
 - b. ASTM F970: Static Load Limit: 750 psi (52.73 kg/sq cm).
 - c. ADA Standards for Accessible Design: Chapter 3, Section 302.1: Floor surfaces shall be stable, firm, and slip-resistant.
 5. Installation:
 - a. Seams: heat weld or S-761 Seam Adhesive
 - b. Adhesives:
 6. Warranty:
 - a. The manufacturer shall warrant the installation to be free of defects in material and workmanship for a period of five (5) years from Date of Substantial Completion.
 - b. The manufacturer shall warrant the product against material defects, or defects in manufacturing, for five (5) years from Date of Substantial Completion.
- C. Homogeneous Vinyl Sheet Floor Covering: **
1. Reference Specification: ASTM F1913, Standard Specification for Vinyl Sheet Floor Covering
 2. Material: A cultured diamond infused coated, nonbacked, nonlayered, homogeneous vinyl composition of polyvinyl chloride resin, plasticizers, stabilizers, fillers and pigments suitable for use on approved subfloors on all grade levels.
 3. Physical Properties:
 - a. Overall Thickness (nom.): 0.080-inches (80 mils) (2.0 mm)
 - b. Wear Layer Thickness (nom.): 0.080-inches (80 mils) (2.0 mm)
 - c. Factory Finish: Diamond 10 Technology coating
 - d. Width: 6'-7"
 4. Performance:
 - a. Fire Test Data:
 - 1) ASTM E648: Critical Radiant Flux: 0.45 watts/sq. cm, minimum: Class 1. **
 - 2) ASTM E662: Smoke Density: 450 or less.
 - b. ASTM F970: Static Load Limit: 750 psi (52.73 kg/sq cm). **
 - c. ADA Standards for Accessible Design: Chapter 3, Section 302.1: Floor surfaces shall be stable, firm, and slip-resistant.
 5. Installation:
 - a. Seams: heat weld or S-761 Seam Adhesive
 - b. Adhesives:
 6. Warranty
 - a. The manufacturer shall warrant the installation to be free of defects in material and workmanship for a period of five (5) years from Date of Substantial Completion.
 - b. The manufacturer shall warrant the product against material defects, or defects in manufacturing, for five (5) years from Date of Substantial Completion.
- D. ~~Physical Properties, General:~~
1. Material: Vulcanized rubber compound 913 with environmentally compatible color pigments that are free of toxic heavy metals like lead, cadmium or mercury.
 2. ~~Performance: Products shall meet or exceed the following standards:~~
 - a. ~~Surface Burning Characteristics: Flame Spread Rating: 15; Smoke Developed: 90.~~
 - b. ~~Smoke Density: Per ASTM E662: 450 or less.~~
 - c. ~~Flammability: Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648: Critical Radiant Flux: 0.45 watts/sq. cm, minimum: Class 1. **~~
 - d. ~~Slip Resistance per ASTM D2047~~
 - e. ~~Static Load: Per AATCC Test Method 134~~
 - f. ~~Hardness: Per ASTM D2240~~
 - g. ~~Static Load Limit: Per ASTM F970: 750 psi (52.73 kg/sq cm). **~~

01-17-2022

- h. ~~ADA Standards for Accessible Design: Chapter 3, Section 302.1: Floor surfaces shall be stable, firm, and slip-resistant.~~
- E. ~~Adhesive:~~
 - 1. ~~Field Areas: Per manufacturer.~~
- F. ~~Warranty:~~
 - 1. ~~Commercial Resilient Limited Warranty: The manufacturer shall warrant the product against material defects, or defects in manufacturing, for ten (10) years from Date of Substantial Completion.~~
 - 2. ~~Installation Warranty: The installer shall warrant the product/s to be free of defects in material and workmanship for a period of one (1) year from Date of Substantial Completion.~~

2.03 INTEGRAL FLASH COVE BASE

- A. Integral Flash Cove Base: Provide integral flash cove wall base by extending sheet flooring 6-inches up the wall using adhesive, welding rod, and accessories recommended and approved by the flooring manufacturer.
- B. Integral Flash Cove Base, scheduled on the Drawings as Finish Type 'IB- #'.
- C. Type IB-1 thru IB-5:
 - 1. Basis of Design: Refer to the "Interior Finish Legend" (Sheet A4.5 of the Drawings) for the manufacturer's name, make or model number, color, size, and other pertinent information for the product to be used.
 - a. Height: 6-inches.

2.04 LUXURY VINYL TILE

- A. Luxury Vinyl Tile Flooring, as scheduled on the Drawings as Finish Type LVT- 1.
 - 1. Product/s: Refer to the "Interior Finish Legend" (Sheet A4.5), and this Article, for pertinent information on this Finish Type.
- B. Luxury Vinyl Tile Flooring System: **
 - 1. Reference Specification: ASTM F1700, Class III, Type B - Embossed Surface.
 - 2. Material: A tough, clear, unfilled polyurethane wear layer composed of polyvinyl chloride resins, plasticizers, stabilizers and processing aids on a filled vinyl backing.
 - 3. Physical Properties:
 - a. Overall Thickness (nom.): 0.125-inches (3.2 mm) (1/8-inch)
 - b. Wear Layer Thickness (nom.): 0.020-inches (0.5 mm)
 - c. Finish: Diamond 10 Technology coating
 - d. Surface Texture: Embossed.
 - e. Nominal Dimensions: As scheduled.
 - f. Installation Method: Direct glue-down.
 - g. Installation Pattern: As scheduled.
 - h. Backing Class: Commercial Grade
 - i. Commercial Traffic: Heavy Commercial.
 - j. Adhesive: Per manufacturer.
 - 4. Performance:
 - a. Fire Test Data:
 - 1) ASTM E648: Critical Radiant Flux: 0.45 watts/sq. cm, minimum: Class 1.
 - 2) ASTM E662: Smoke Density: 450 or less.
 - b. ASTM F970: Static Load Limit: 250 psi (17.6 kg/sq cm).
 - c. ADA Standards for Accessible Design: Chapter 3, Section 302.1: Floor surfaces shall be stable, firm, and slip-resistant.
 - 5. Installation:
 - a. Adhesives: Per manufacturer
 - 6. Warranty:
 - a. The manufacturer shall warrant the installation to be free of defects in material and workmanship for a period of twenty (20) years from Date of Substantial Completion.

- b. The manufacturer shall warrant the product against material defects, or defects in manufacturing, for twenty (20) years from Date of Substantial Completion.
- C. ~~Physical Properties, General:~~
 - 1. Material: Vulcanized rubber compound 926 with environmentally compatible color pigments that are free of toxic heavy metals like lead, cadmium or mercury.
 - 2. Composition: Homogeneous rubber compound with with a random scattered design.
 - 3. Performance:
 - a. Surface Burning (CAN/ULC-S102.2): Flame Spread: 70; Smoke Developed: 470.
 - b. Fire Performance:
 - 1) ASTM E648: Tested Class I.
 - 2) ASTM E662: Less than 450.
 - c. Flammability: 0.92 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 - d. Smoke Density: ASTM E662: Passes, equal to or less than 450.
 - e. Static Load Resistance: 1,500 psi minimum, when tested as specified in ASTM F970.
 - f. Slip Resistance (ASTM D2047): Static coefficient of friction: Dry: 0.55; Wet: 0.55.
 - g. Bacteria Resistance (ASTM E2180 / ASTM G21): Passed.
 - h. Chemical Resistance (ASTM F925): Passes.
 - i. Hardness (ASTM D2240): Shore type "A", 82 achieved.
 - j. Load Limit: 850 lbs/sq. in.
 - k. Static Generation (AATCC Test Method 134): < 2000 Volts at 20% RH, achieved.
- D. ~~Warranty:~~
 - 1. Manufacturer's Warranty: The manufacturer shall warrant the product against material defects, or defects in manufacturing, for fifteen (15) years from Date of Substantial Completion.
 - 2. Installation Warranty: The installer shall warrant the product/s to be free of defects in material and workmanship for a period of one (1) year from Date of Substantial Completion.
- E. ~~Type LVT-4:~~
 - 1. Manufacturer: As scheduled.
 - 2. Product: As scheduled.
 - 3. Product Requirements:
 - a. Minimum Requirements: Comply with ASTM F1700, Class III, Type B.
 - b. Nominal Dimensions: As scheduled.
 - c. Installation Method: Direct glue-down.
 - d. Installation Pattern: As scheduled.
 - e. Backing Class: Commercial Grade
 - f. Commercial Traffic: Heavy Commercial.
 - g. Adhesive: Per manufacturer.
 - h. Performance:
 - 1) Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 (NFPA 253): Class I.
 - 2) ASTM E662 (NFPA 258) Smoke Density: 450 or less.
 - 3) ADA Standards for Accessible Design: Chapter 3, Section 302.1: Floor surfaces shall be stable, firm, and slip-resistant.
 - i. Warranty: Provide a twenty (20) year Commercial Resilient Limited Warranty from Date of Substantial Completion.

2.05 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. Resilient Moldings, Transition and Edge Strips: See Section 09 65 13 - Resilient Base and Accessories.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for resilient flooring installation by testing for moisture and pH.
 - 1. Test in accordance with Section 01 45 00 - Concrete In-Situ Relative Humidity and pH Testing.
 - 2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

3.03 INSTALLATION - GENERAL

- A. Install in accordance with manufacturer's instructions, approved submittals, and in proper relationship with adjacent materials.
- B. Starting installation constitutes acceptance of sub-floor conditions.
- C. Spread only enough adhesive to permit installation of materials before initial set.
- D. Fit joints and butt seams tightly.
- E. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
- F. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
 - 1. Resilient Strips: Attach to substrate using adhesive.
- G. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.04 INSTALLATION - SHEET FLOORING

- A. Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns at seams.
- B. Seal seams by heat welding where indicated.
- C. Chemically bond seams using seam sealer where indicated.

3.05 CLEANING

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

3.06 PROTECTION

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

END OF SECTION 09 65 00

**SECTION 09 65 13
RESILIENT BASE AND ACCESSORIES**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Resilient wall base.

1.03 RELATED SECTIONS

Section 09 65 00 - Resilient Flooring

Section 09 68 13 - Tile Carpeting

1.04 SUBMITTALS

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

1.05 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
- B. Mockups: Provide resilient products with mockups specified in other Sections.

1.06 DELIVERY, STORAGE AND HANDLING

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

1.07 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 65 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Install resilient products after other finishing operations, including painting, have been completed.

1.08 EXTRA MATERIALS

- A. Deliver extra resilient base units for Owner's use in maintenance. Label and store where directed by the Owner including codes used on the Drawings. Do not deliver to the Project site until the Owner is prepared to receive and store maintenance materials.
 - 1. Furnish not less than 10 linear feet for every 500 linear feet, or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.09 WARRANTY

- A. Warranty: Provide manufacturer's standard warranty against manufacturing defects in material or workmanship during the warranty period.
 - 1. Warranty Period: One (1) year from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Specified Manufacturer: Johnsonite.
 - 1. Other Acceptable Manufacturer: None identified. No substitutions will be considered or accepted.

2.02 MATERIALS

- A. Rubber Wall Base and Accessories: Meet or exceed the requirements of ASTM F1861, Type TS (Thermoset) rubber formulations, Group 1 (solid).
 - 1. Construction: 100% vulcanized homogenous rubber compound comprised of a premium blend and SBR rubber materials.

2.03 PERFORMANCE REQUIREMENTS

- A. Materials shall meet or exceed the following performance criteria:
 - 1. Flame Spread / Smoke Density (ASTM E84): Class B.
 - 2. Flammability / Critical Radiant Flux (ASTM E648): Class I.
 - 3. Smoke Density (ASTM E662): < 450: Passes.
 - 4. Flexibility (ASTM F137): Passes.
 - 5. Color Stability: Meets or exceeds ASTM F1861 requirements for color stability when tested to ASTM F1515.
 - 6. Chemical Resistant (ASTM D925): Passed.
 - 7. SCS FloorScore® Certified.
- B. Manufacturing facility shall be ISO 9001 and ISO 14001 Certified.

2.04 RESILIENT WALL BASE

- A. Resilient Base, scheduled on the Drawings as Finish Type RB- #.
 - 1. Product/s: Refer to the "Interior Finish Legend" (Sheet A4.2) for pertinent information on this Finish Type.
- B. General:
 - 1. Classification: ASTM F1861, Type TS - rubber, vulcanized thermoset, Group 1.
 - 2. Material & Composition: 100% vulcanized homogenous rubber compound comprised of a premium blend and SBR rubber materials.
 - a. Phthalate, chlorine and halogen free.
 - b. 100% Recyclable.
 - c. Contains 2.3% rapidly renewable content.
- C. Type RB-1:
 - 1. Product: Johnsonite; "Baseworks Thermoset Rubber Wall Base".
 - 2. Classification: ASTM F1861, Type TS - rubber, vulcanized thermoset, Group 1.
 - 3. Material & Composition: 100% vulcanized homogenous rubber compound comprised of a premium blend and SBR rubber materials.
 - 4. Product Requirements:
 - a. Thickness: 1/8 inch.
 - b. Height: 4 inches.
 - c. Profile: Toe.
 - d. Length: 8-foot lengths or 120-foot coils.
 - e. Outside Corners: Mitered.
 - f. Inside Corners: Mitered or coped.

2.05 INSTALLATION MATERIALS

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

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

3.02 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- C. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.03 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

3.04 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.
- B. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

END OF SECTION 09 65 13

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SECTION 09 68 13
TILE CARPETING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Modular, Tufted Carpet Tile.
- B. Accessories.

1.03 RELATED SECTIONS

- A. Section 01 45 00 - Concrete In-Situ Relative Humidity and pH Testing
- B. Section 03 30 00 - Cast-in-Place Concrete
- C. Section 09 30 50 - Metal Edge Protection and Transition Profiles
- D. Section 09 65 13 - Resilient Base and Accessories

1.04 REFERENCE STANDARDS

- A. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials 2016 (Reapproved 2021).
- B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source 2019a, with Editorial Revision (2020).
- C. ASTM E662 - Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials 2021a, with Editorial Revision.
- D. CRI 104 - Standard for Installation of Commercial Carpet 2015.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- C. Samples: Submit two samples, 24-inches by 24-inches in size illustrating color and pattern for each carpet material specified.
- D. Manufacturer's Installation Instructions: Indicate special procedures.
- E. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Carpet Tile: For each type specified, provide full-size tiles in unopened boxes equal to but not less than 5-percent of quantity installed.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in installing carpet with minimum three years documented experience.
- C. Fire-Test-Response Ratings: Where indicated, provide carpet tile identical to those of assemblies tested for fire response according to NFPA 253 by a qualified testing agency.

1.07 FIELD CONDITIONS

- A. Store materials in area of installation for minimum period of 24 hours prior to installation.
- B. Maintain minimum 70 degrees F (21 degrees C) ambient temperature 24 hours prior to, during and 24 hours after installation.

- C. Ventilate installation area during installation and for 72 hours after installation.
- D. Comply with CRI 104 for temperature, humidity, and ventilation limitations.
- E. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.
- F. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

1.08 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 - 2. Failures include, but are not limited to, more than 10 percent edge raveling, snags, runs, dimensional stability, excess static discharge, loss of tuft bind strength, loss of face fiber, and delamination.
 - 3. Warranty Period: 10 years from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Specified Manufacturer: Interface.
 - 1. Other Acceptable Manufacturer: None identified. No substitutions will be considered or accepted.

2.02 WALK-OFF CARPET TILE

- A. Walk-off Carpet Tile, scheduled on the Drawings as Finish Type WOC- #.
 - 1. Product/s: Refer to the "Interior Finish Legend" (Sheet A4.2) for pertinent information on this Finish Type.
- B. Walk-off Carpet, Type WOC-1:
 - 1. Manufacturer: Shaw Contract.
 - 2. Style: As scheduled.
 - 3. Collection: As scheduled.
 - 4. Construction: Multi-level pattern loop
 - 5. Size: As scheduled
 - 6. Primary Backing: Per Manufacturer.
 - 7. Secondary Backing: Per Manufacturer.
 - 8. Fiber: Per Manufacturer.
 - 9. Dye Method: 100% solution dyed.
 - 10. Tufted Weight: 28.0 oz/yd²
 - 11. Installation Method: As scheduled.
 - 12. Color: As scheduled.
 - 13. Performance:
 - a. Radiant Panel (ASTM E648): Class I.
 - b. Smoke Generation (ASTM E662): Less than 450.
 - c. Electrostatic Propensity: less than 3.5 kv.
 - d. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").
 - 14. Warranty: Lifetime commercial limited.

2.03 CARPET TILE

- A. Carpet Tile, scheduled on the Drawings as Finish Type CPT-1.
 - 1. Product/s: Refer to the "Interior Finish Legend" (Sheet A4.2) for pertinent information on this Finish Type.
- B. Performance:

1. Radiant Panel (ASTM E648): Class I.
2. Smoke Generation (ASTM E662): Less than 450.
3. Lightfastness (AATCC 16 - E): ≥ 4.0 @ 60 AFU's.
4. Static (AATCC - 134): < 3.0 KV
5. Flammability (ASTM D2859): Passes Methenamine Pill Test.
6. Traffic Classification: Heavy.

2.04 ACCESSORIES

- A. Sub-Floor Filler: Type recommended by carpet manufacturer.
- B. Resilient Transition Strips: Refer to Section 09 65 13 - Resilient Base and Accessories.
- C. Metal Edge Protection: Refer to Section 09 30 50 - Metal Edge Protection and Transition Profiles
 1. Provide transition/reducing strips tapered to meet abutting materials as indicated in the drawings.
- D. Carpet Adhesive: Recommended by carpet manufacturer; releasable type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive carpet.
- B. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for flooring installation by testing for moisture and alkalinity (pH).
 1. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.

3.02 PREPARATION

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

3.03 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install carpet tile in accordance with manufacturer's instructions and CRI 104 (Commercial).
- C. Verify carpet match before cutting to ensure minimal variation between dye lots.
- D. Install carpet tight and flat on subfloor, with a uniform appearance.

3.04 DIRECT-GLUED CARPET

- A. Apply contact adhesive to floor uniformly at rate recommended by manufacturer. After sufficient open time, press carpet into adhesive.
- B. Roll with appropriate roller for complete contact of adhesive to carpet backing.
- C. Trim carpet neatly at walls and around interruptions.

3.05 CLEANING

- A. Clean and vacuum carpet surfaces.

END OF SECTION 09 68 13

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**SECTION 09 91 23
INTERIOR PAINTING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation and the field application of paints, stains, and varnishes on interior substrates (i.e. steel, galvanized metal, aluminum, wood, masonry, gypsum board, etc.) as indicated in the drawings and specified below.

1.02 RELATED REQUIREMENTS

- A. Section 079200 - Joint Sealants
- B. Section 09 21 16 - Gypsum Board Assemblies

1.03 DEFINITIONS

- A. Comply with ASTM D16 for interpretation of terms used in this section.
- B. Gloss Levels, according to ASTM D523:
 - 1. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees.
 - 2. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees.
 - 3. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees.
 - 4. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees.
 - 5. Gloss Level 5: 35 to 70 units at 60 degrees.
 - 6. Gloss Level 6: 70 to 85 units at 60 degrees.
 - 7. Gloss Level 7: More than 85 units at 60 degrees.

1.04 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency current edition.
- B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications 2019.
- C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials 2020.
- D. ASTM D523 - Standard Test Method for Specular Gloss 2014 (Reapproved 2018).
- E. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association Current Edition.
- F. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual Current Edition.
- G. SSPC-PA 1 - Shop, Field, and Maintenance Painting of Steel 2016.
- H. SSPC-SP 13 - Surface Preparation of Concrete 2018.

1.05 SUBMITTALS

- A. Product Data: Provide complete list of products to be used, with the following information for each type of topcoat product:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
 - 2. MPI product number (e.g. MPI #47).
 - 3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
 - 4. VOC Content.
- B. Samples: Submit two paper "draw down" samples, 8-1/2 by 11 inches (216 by 279 mm) in size, illustrating range of colors available for each finishing product specified.
 - 1. Where sheen is specified, submit samples in only that sheen.
 - 2. Allow 30 days for approval process, after receipt of complete samples by Architect.

01-17-2022

- a. Paint color submittals will not be considered until color submittals for major materials not to be painted, such as factory finished metals, have been approved.
- C. Certification: By manufacturer that paints and finishes comply with VOC limits specified.
- D. Manufacturer's Instructions: Indicate special surface preparation procedures.
- E. Maintenance Data: Submit data including finish schedule showing where each product/color/finish was used, product technical data sheets, material safety data sheets (MSDS), care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Deliver extra paint for Owner's use in maintenance. Label and store where directed by the Owner including codes used on the Drawings. Do not deliver to the Project site until the Owner is prepared to receive and store maintenance materials.
 - 1. Paint: For each color and material specified, furnish quantity of unopened 1-gallon cans equal to no less than 5 percent of quantity installed. Paint must be from the same product run.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum three years documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum three years experience and approved by manufacturer.

1.08 COORDINATION:

- A. Provide finish coats which are compatible with the prime coats actually used.
- B. Review other Sections of these Specifications as required, verifying the primer coats to be used and assuring compatibility of the total coating system for the various substrate.
- C. Furnish information on the characteristics of the specific finish materials to assure that compatible primer coats are used.
- D. Provide barrier coats over non-compatible primers, or remove the primer and re-prime as required.
- E. Notify the Architect in writing of anticipated problems in using the specified coating system over prime-coatings supplied under other Sections.

1.09 MOCK-UP

- A. Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.11 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Provide lighting level of 80 ft candles (860 lx) measured mid-height at substrate surface.

1.12 MATERIAL DISPOSAL

- A. Paint, stain and wood preservative finishes and related materials (thinners, solvents, etc.) are regarded as hazardous products and are subject to regulations for disposal. Obtain information on these controls from the Authority having jurisdiction.
- B. All waste materials shall be separated and recycled. Where paint recycling is available, collect waste paint by type and provide for delivery to recycling or collection facility. Materials that cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.
- C. Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.
- D. To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into the ground, the following procedures shall be strictly adhered to:
 - 1. **FLOOR DRAINS OR SINKS CONNECTED TO THE BUILDING SANITARY SEWER SYSTEM SHALL NOT BE USED TO CLEAN BRUSHES, EQUIPMENT, ETC.**
 - 2. Retain cleaning water for water-based materials to allow sediments to be filtered out. In no case shall equipment be cleaned using free draining water.
 - 3. Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.
 - 4. Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.
 - 5. Dispose of contaminants in an approved legal manner in accordance with hazardous waste regulations.
 - 6. Empty paint cans are to be dry prior to disposal or recycling (where available).
 - 7. Close and seal tightly partly used cans of materials including sealant and adhesive containers and store protected in well ventilated fire-safe area at moderate temperature.
 - 8. Set aside and protect surplus and uncontaminated finish materials not required by the Owner and deliver or arrange collection for verifiable re-use or re-manufacturing.

1.13 GUARANTEE

- A. Furnish either the local MPI Accredited Quality Assurance Association's two (2) year guarantee, or, alternatively, a 100% two (2) year Maintenance Bond - both in accordance with MPI Painting Manual requirements. The Maintenance Bond shall warrant that all painting work has been performed in accordance with MPI Painting Manual requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Specified Manufacturers: The Sherwin-Williams Paint Company;
 - 1. Other Acceptable Manufacturer: None identified. No substitutions will be considered or accepted.
 - 2. Manufacturer Contacts:

- a. Local Sales Rep: Brook Nienstedt: P: (913) 381-8633 / E-mail:
brook.b.nienstedt@sherwin.com.

2.02 PAINT - GENERAL REQUIREMENTS

- A. Paints and Finishes: Ready mixed, unless intended to be a field-catalyzed paint.
- B. MPI Standards: Where MPI paint numbers are specified, provide products listed in Master Painters Institute Approved Product List, current edition available at www.paintinfo.com, for specified MPI categories, except as otherwise indicated.
- C. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
- D. Unless noted otherwise, typical paint system consists of:
 - 1. One (1) Coat of Primer/Filler
 - 2. One (1) Intermediate Coat
 - 3. One (1) Top Coat
- E. Tinting of Paint Finishes: Tint each coat as follows:
 - 1. Primer Coat: Do NOT tint primer coat.
 - 2. Intermediate Coat/s: Tint intermediate coat/s as base color, applied with a FLAT sheen.
 - 3. Top Coat: Final finish coat shall be applied as base color with the specified sheen.
- F. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- G. Material Compatability:
 - 1. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- H. Volatile Organic Compound (VOC) Content:
 - 1. Provide paints and finishes that comply with the most stringent requirements specified in 40 CFR 59, Subpart D (EPA Method 24) - National Volatile Organic Compound Emission Standards for Architectural Coatings.
 - a. Flat Paint and Coatings: 50 g/L, maximum.
 - b. Non-Flat Paint and Coatings: 150 g/L, maximum.
 - c. Primers, Sealers, and Undercoaters: 200 g/L.
 - d. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 - e. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
 - f. Pretreatment Wash Primers: 420 g/L.
 - g. Floor Coatings: 100 g/L.
 - h. Shellacs, Clear: 730 g/L.
 - i. Shellacs, Pigmented: 550 g/L.
 - 2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.
- I. Flammability: Comply with applicable code for surface burning characteristics.

2.03 PAINT FINISHES - COLOR AND SHEEN

- A. Paint Finishes, types designated in the drawings as Finish Type P- #.
 - 1. Refer to the "Interior Finish Legend" (Sheet A4.2) for the manufacturer, color number, color name, sheen, and other pertinent information for the paints specified.
- B. Colors: As scheduled.
- C. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.

01-17-2022

2.04 SOURCE QUALITY CONTROL

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

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished, with Applicator present, prior to commencement of work. Report any condition that may potentially effect proper application.
- C. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Gypsum Wallboard: 12 percent.
 - 2. Masonry, Concrete, and Concrete Masonry Units: 12 percent.
 - 3. Interior Wood: 15 percent, measured in accordance with ASTM D4442.
 - 4. Concrete Floors and Traffic Surfaces: 8 percent.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- F. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
 - 1. Prepare surface as recommended by top coat manufacturer and according to SSPC-SP 13.
- G. Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions. Allow to dry.
- H. Concrete Floors and Traffic Surfaces: Remove contamination, acid etch, and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.
- I. Gypsum Board Substrates: Fill minor defects with filler compound. Spot prime defects after repair.
- J. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

01-17-2022

- K. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- L. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.
- M. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

3.03 APPLICATION

- A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - a. 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.
 - 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. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tinting:
 - 1. Tint intermediate coat/s to match color of finish topcoat, but provide FLAT sheen to distinguish each separate coat. Do NOT tint primer 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. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- E. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
- F. Sand wood and metal surfaces lightly between coats to achieve required finish.
 - 1. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- G. Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
 - 1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
 - 2. Prime surfaces to receive wall coverings.
 - 3. Painting of Exposed Roof Structure:
 - a. In finished occupied areas, paint roof deck, bar joists, girders, beams, and columns, unless otherwise indicated.
 - 4. Painting of Mechanical and Electrical Materials Exposed to View:
 - a. In finished occupied areas, paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
 - b. In finished areas, paint shop-primed items.
 - c. Paint interior surfaces of air ducts that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
 - d. Paint dampers exposed behind louvers and grilles to match face panels.
- H. Do NOT paint or finish the following work items:

01-17-2022

1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 2. Items indicated to receive other finishes.
 3. Items indicated to remain unfinished.
 - 4.
 5. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
 6. Stainless steel, anodized aluminum, bronze, terne coated stainless steel, and lead items.
 7. Marble, granite, slate, and other natural stones.
 8. Floors, unless specifically indicated.
 9. Ceramic and other tiles.
 10. Glass.
 11. Wall, ceilings, floors, and mechanical/electrical work located in utility, mechanical, and electrical spaces, unless indicated otherwise.
 12. Acoustical materials, unless specifically indicated.
 13. Concealed pipes, ducts, and conduits.
- I. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 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.

3.05 CLEANING AND PROTECTION

- A. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.
- B. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
1. Refer to "Material Disposal" Article in this Section.
- C. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- D. 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.
- E. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

PART 4 - PAINT SCHEDULE

4.01 INTERIOR COATING SYSTEMS - WALL SURFACES

- A. Concrete and Concrete Masonry Units (CMU):
1. Latex System:
 - a. Semi-Gloss Finish:
 - 1) Filler: PrepRite® Block Filler, B25W25
 - 2) Intermediate Coat: ProMar® 200 Zero VOC Interior Latex Semi-Gloss, B31-2600 Series
 - 3) Top Coat: ProMar® 200 Zero VOC Interior Latex Semi-Gloss , B31-2600 Series
 - b. Eg-Shel Finish:
 - 1) Filler: PrepRite® Block Filler, B25W25

01-17-2022

- 2) Intermediate Coat: ProMar® 200 Zero VOC Interior Latex Eg-Shel, B20-2600 Series
 - 3) Top Coat: ProMar® 200 Zero VOC Interior Latex Eg-Shel, B20-2600 Series
 2. Pre-Catalyzed Waterbased Epoxy System:
 - a. Semi-Gloss Finish:
 - 1) Primer: PrepRite® Block Filler, B25W25
 - 2) Intermediate Coat: Pro Industrial™ Pre-Catalyzed Waterbased Epoxy, Semi-Gloss, K46-151 Series
 - 3) Top Coat: Pro Industrial™ Pre-Catalyzed Waterbased Epoxy, Semi-Gloss, K46-151 Series
 - b. Eg-Shel Finish:
 - 1) Filler: PrepRite® Block Filler, B25W25
 - 2) Intermediate Coat: Pro Industrial™ Pre-Catalyzed Waterbased Epoxy Eg-Shel, K45-151 Series
 - 3) Top Coat: Pro Industrial™ Pre-Catalyzed Waterbased Epoxy Eg-Shel, K45-151 Series
- B. Gypsum Board Substrates:
 1. Institutional Low-Odor/VOC Interior Latex System:
 - a. Eg-Shel Finish:
 - 1) Primer: Harmony Interior Latex Primer, B11W900 Series
 - 2) Intermediate Coat: Harmony Interior Latex Flat
 - 3) Top Coat: Harmony Interior Latex Eg-Shel, B9 Series
 2. Interior Epoxy-Modified Latex System:
 - a. Gloss Finish:
 - 1) Primer: ProMar® 200 Zero VOC Latex Primer, B28W2600
 - 2) Intermediate Coat: Pro Industrial™ Waterbased Catalyzed Epoxy Gloss, B73-300 Series
 - 3) Top Coat: Pro Industrial™ Waterbased Catalyzed Epoxy Gloss, B73-300 Series

4.02 INTERIOR COATING SYSTEMS - CEILING AND SOFFIT SURFACES

- A. Gypsum Board:
 1. Institutional Low Odor/VOC Interior Latex System:
 - a. Flat Finish:
 - 1) Primer: Harmony Interior Latex Primer, B11W900 Series
 - 2) Intermediate Coat: Harmony Interior Latex Flat, B9 Series
 - 3) Top Coat: Harmony Interior Latex Flat, B9 Series

4.03 INTERIOR COATING SYSTEMS - FLOOR SURFACES

- A. Concrete Floors:
 1. Light Duty Industrial Floor Coatings:
 - a. Acrylic Systems:
 - 1) 1st Coat: ArmorSeal® Tread-Plex™ Waterbased Acrylic Primer , B90 Series
 - 2) 2nd Coat: ArmorSeal® Tread-Plex™, B90 Series
 - 3) 3rd Coat: ArmorSeal® Tread-Plex™, B90 Series
 2. Moderate Duty Industrial Floors:
 - a. Water Based Epoxy Primer / Water Based Epoxy Coating System:
 - 1) 1st Coat: ArmorSeal Water Based Epoxy Primer/Sealer Clear, B70VQ10
 - 2) 2nd Coat: ArmorSeal® 8100 Water Based Epoxy, B70-8100 Series
 - 3) 3rd Coat: ArmorSeal® 8100 Water Based Epoxy, B70-8100 Series
 - b. Epoxy System:
 - 1) 1st Coat: ArmorSeal 1000 HS Epoxy, B67-2000 Series
 - 2) 2nd Coat: ArmorSeal 1000 HS Epoxy, B67-2000 Series
 - 3) 3rd Coat (optional): ArmorSeal 1000 HS Epoxy, B67-2000 Series
 3. Heavy Duty Industrial Floors:
 - a. Epoxy / HS Polyurethane System:

01-17-2022

- 1) 1st Coat: ArmorSeal 1000 HS Epoxy, B67-2000 Series
- 2) 2nd Coat: ArmorSeal HS Polyurethane, B65-220 Series
- 3) 3rd Coat (optional): ArmorSeal HS Polyurethane, B65-220 Series

B. Wood Floors:

1. Semi-Transparent Stain Finish:
 - a. 1st Coat: S-W Minwax Performance Series Tintable Wood Stain 550 VOC
 - b. 2nd Coat: S-W Minwax Waterbased Oil-Modified Polyurethane
 - c. 3rd Coat: S-W Minwax Waterbased Oil-Modified Polyurethane
 - d. Sheen: Gloss, Semi-Gloss, Satin
2. Clear Finish: Polyurethane
 - a. 1st Coat: S-W Minwax Fast Drying Polyurethane Varnish
 - b. 2nd Coat: S-W Minwax Fast Drying Polyurethane Varnish
 - c. Sheen: Gloss, Semi-Gloss, Satin

4.04 INTERIOR COATING SYSTEMS - WOOD SURFACES

- A. Opaque Finishes: Provide the following opaque paint finish systems over interior wood surfaces, if indicated in the drawings:
1. Waterbased/Alkyd Urethane System:
 - a. Gloss Finish:
 - 1) Primer: S-W Premium Wall & Wood Primer, B28W8111 Series
 - 2) Intermediate Coat: Pro Industrial Waterbased Alkyd Urethane Gloss, B53-1050 Series
 - 3) Top Coat: Pro Industrial Waterbased Alkyd Urethane Gloss, B53-1050 Series
 - b. Semi-Gloss Finish:
 - 1) Primer: S-W Premium Wall & Wood Primer, B28W8111 Series
 - 2) Intermediate Coat: Pro Industrial Waterbased Alkyd Urethane Semi-Gloss, B53-1150 Series
 - 3) Top Coat: Pro Industrial Waterbased Alkyd Urethane Semi-Gloss, B53-1150 Series
 2. Latex System:
 - a. Gloss Finish:
 - 1) Primer: PrepRite® ProBlock® Latex Primer/Sealer, B51-620 Series
 - 2) Intermediate Coat: ProMar 200 Zero VOC Gloss, B21-12650 Series
 - 3) Top Coat: ProMar 200 Zero VOC Gloss, B21-12650 Series
 - b. Semi-Gloss Finish:
 - 1) Primer: PrepRite® ProBlock® Latex Primer/Sealer, B51-620 Series
 - 2) Intermediate Coat: ProMar 200 Zero VOC Latex Semi-Gloss, B31-2600 Series
 - 3) Top Coat: ProMar 200 Zero VOC Latex Semi-Gloss, B31-2600 Series
 3. Water-Based Light Industrial Coating System:
 - a. Semi-Gloss Finish:
 - 1) Primer: PrepRite® ProBlock® Latex Primer/Sealer, B51 Series
 - 2) Intermediate Coat: Pro Industrial™ Pre-Catalyzed Waterbased Epoxy Semi-Gloss, K46-151 Series
 - 3) Top Coat: Pro Industrial™ Pre-Catalyzed Waterbased Epoxy Semi-Gloss, K46-151 Series
- B. Clear Finishes:
1. Polyurethane System
 - a. 1st Coat: S-W Minwax Fast Drying Polyurethane, Satin
 - b. 2nd Coat: S-W Minwax Fast Drying Polyurethane, Satin
 2. Alkyd System:
 - a. 1st Coat: S-W Minwax Performance Series Fast-Dry Sanding Sealer
 - b. 2nd Coat: S-W Minwax Performance Series Fast-Dry Oil Varnish, Satin
 - c. 3rd Coat: S-W Minwax Performance Series Fast-Dry Oil Varnish, Satin
- C. Semi-Transparent Finishes:

01-17-2022

1. Polyurethane (topcoat):
 - a. 1st Coat: S-W Minwax Performance Series Tintable Wood Stain 250
 - b. 2nd Coat: S-W Minwax Fast Drying Polyurethane Varnish, Satin
 - c. 3rd Coat: S-W Minwax Fast Drying Polyurethane Varnish , Satin
2. Alkyd (topcoat):
 - a. 1st Coat: S-W Minwax Performance Series Tintable Wood Stain 250 VOC
 - b. 2nd Coat: S-W Minwax Performance Series Fast-Dry Sanding Sealer
 - c. 3rd Coat: S-W Minwax Performance Series Fast-Dry Oil Varnish, Satin
 - d. 4th Coat: S-W Minwax Performance Series Fast-Dry Oil Varnish, Satin

4.05 INTERIOR COATING SYSTEMS - METAL SURFACES

- A. Ferrous Metal: Includes, but not limited to, interior metal doors, door frames and miscellaneous metals, if indicated in the drawings:

1. Latex System:
 - a. Semi-Gloss Finish:
 - 1) Primer: Pro Industrial™ Prep-Ritel® Bonding Primer, XXX Series (MPI #17)
 - (a) Shop Primed Surfaces: Except for "touch-up," prime coat may be omitted. Verify compatibility and application of finish coat over shop primer with paint manufacturer.
 - 2) Intermediate Coat: Pro Industrial™ Acrylic Semi-Gloss, B66-650 Series
 - 3) Top Coat: Pro Industrial™ Acrylic Semi-Gloss, B66-650 Series

- B. Non-Ferrous (Galvanized) Metal Substrates:

1. Latex System:
 - a. Semi-Gloss Finish:
 - 1) Primer: Pro Industrial™ Pro-Cryl® Universal Primer, B66-310 Series
 - (a) Shop Primed Surfaces: Except for "touch-up," prime coat may be omitted. Verify compatibility and application of finish coat over shop primer with paint manufacturer.
 - 2) Intermediate Coat: Pro Industrial™ Acrylic Semi-Gloss, B66-650 Series
 - 3) Top Coat: Pro Industrial™ Acrylic Semi-Gloss, B66-650 Series
2. Epoxy-Modified Latex System:
 - a. Gloss Finish:
 - 1) Primer: Pro Industrial™ Pro-Cryl® Universal Primer, B66-310 Series
 - 2) Intermediate Coat: Pro Industrial™ Water Based Catalyzed Epoxy Gloss, B73-300 Series
 - 3) Top Coat: Pro Industrial™ Water Based Catalyzed Epoxy Gloss, B73-300 Series
3. Pre-Catalyzed Waterbased Epoxy System:
 - a. Semi-Gloss Finish:
 - 1) Primer: Pro Industrial™ Pro-Cryl® Universal Primer, B66-310 Series
 - 2) Intermediate Coat: Pro Industrial™ Pre-Catalyzed Waterbased Epoxy Semi-Gloss, K46 Series
 - 3) Top Coat: Pro Industrial™ Pre-Catalyzed Waterbased Epoxy Semi-Gloss, K46 Series

- C. Ferrous and Non-Ferrous Metals at Exposed Ceiling Conditions:

1. Exposed roof structure and overhead-mounted services in utilitarian spaces shall be painted, to include steel roof decking, bar joists, structural steel, metal fabrications, ductwork, conduit, piping, etc.
2. Ferrous and Non-Ferrous Metals:
 - a. Latex Dryfall:
 - 1) Eg-Shel Finish:
 - (a) Primer: Pro Industrial™ Pro-Cryl® Universal Primer, B66-310 Series
 - (1) Shop Primed Surfaces: Except for "touch-up," prime coat may be omitted. Verify compatibility and application of finish coat over shop

- primer with paint manufacturer.
- (b) Top Coat: Pro Industrial™ Waterborne Acrylic Dryfall Eg-Shel, XX Series, (MPI #155)
- (c) 2nd coat (as required): Pro Industrial™ Waterborne Acrylic Dryfall Eg-Shel, XX Series (MPI #155)
- 2) Flat Finish:
 - (a) Primer: Pro Industrial™ Pro-Cryl® Universal Primer, B66-310 Series
 - (1) Shop Primed Surfaces: Except for “touch-up,” prime coat may be omitted. Verify compatibility and application of finish coat over shop primer with paint manufacturer.
 - (b) Top Coat: Pro Industrial™ Waterborne Acrylic Dryfall Flat, B42-80 Series, (MPI #118)
 - (c) 2nd coat (as required): Pro Industrial™ Waterborne Acrylic Dryfall Flat, B42-80 Series (MPI #118)

END OF SECTION 09 91 23

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SECTION 10 26 13
WALL PROTECTION PANELS AND CORNER GUARDS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Corner guard systems.
- B. Wall protection panel systems.
- C. Corridor handrails.

1.03 RELATED SECTIONS

- A. Section 06 10 00 - Rough Carpentry
- B. Section 09 21 16 - Gypsum Board Assemblies

1.04 REFERENCE STANDARDS

- A. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics 2010 (Reapproved 2018).
- B. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position 2018.
- C. ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents 2020.
- D. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015 (Reapproved 2021)e1.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- F. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials 2020.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures.
- B. Product Data: Indicate physical dimensions, features, anchorage details, and rough-in measurements.
- C. Samples: Verification samples of corner guard, 8-inches (203mm) long, in full size profiles of each type and color indicated.

1.06 WARRANTY

- A. Standard Manufacturer's Limited Lifetime Warranty against material and manufacturing defects.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Specified Manufacturers: Koroseal.

2.02 WALL PROTECTION PANELS

- A. Wall Protection Panels, scheduled on the Drawings as Finish Type 'WP-1'
 - 1. Refer to the "Interior Finish Legend" (Sheet A4.2) for pertinent information on this Finish Type.
- B. Product: As identified in Finish Legend.
 - 1. Material: Rigid Vinyl Sheet: Manufactured from chemical and stain resistant polyvinyl chloride with the addition of impact modifiers. No plasticizers shall be added.
 - 2. Thickness: 0.040 inches.

01-17-2022

3. Panel Width: 36-inches or 48-inches.
4. Panel Length: 96-inches.
5. Fire Rating: Class A.
6. Adhesive: As recommended by manufacturer.
- C. Accessories:
 1. Top caps (#407), vertical divider bars (#408), inside corners (#409), and outside corners shall be made of extruded PVC.
- D. Finishes:
 1. Surface Texture: Velvet Texture.
 2. Color: As scheduled.
 3. Vinyl Accessories: Top caps, inside corners, divider bars and outside corners shall be of a color matching the wall panels.
- E. Performance Requirements:
 1. Fire Performance Characteristics: Provide UL Classified wall protection panels conforming with the NFPA Class A fire rating.
 2. Surface Burning Characteristics: Provide assemblies with flame spread index of 20 and smoke developed index of 350, when tested in accordance with ASTM E84.
 3. Fire Resistance: Where fire rating is specified for the wall in which the guard is mounted, provide assemblies that have been tested in accordance with ASTM E119 for the same rating as the wall.
 4. Self-Extinguishing: Provide CC1 classification, as tested in accordance with the procedures specified in ASTM D635.
 5. Resist lateral impact force of 100 lbs (445 N) at any point without damage or permanent set.
 6. Support vertical live load of 100 lb/lineal ft (1,400 N/m) with deflection not to exceed 1/50 of span between supports.
 7. Impact Strength: 30.40 ft-lbs/inch of thickness as tested in accordance with the procedures specified in ASTM D256.
 8. Chemical and stain resistance: Provide wall protection system components with chemical and stain resistance in accordance with ASTM D543.
 9. Fungal and Bacterial Resistance: Provide rigid vinyl that does not support fungal or bacterial growth as tested in accordance with ASTM G21.

2.03 CORNER GUARDS

- A. Corner Guards, scheduled on Drawings as Finish Type 'CG-1'.
 1. Basis of Design: Refer to the "Interior Finish Legend" (Sheet A4.2) for pertinent information on this Finish Type.
- B. Type []: Surface Mounted:
 1. Refer to the "Interior Finish Legend" (Sheet A4.2) for pertinent information on this Finish Type.
 2. Product: As identified in Finish Legend.
 - a. Construction: High impact vinyl with full height extruded aluminum retainer.
 - b. Profile: As scheduled.
 - c. Corner: Square.
 - d. Color: As scheduled.
 - e. Length: Full height of wall less wall base.
 3. Material:
 - a. Vinyl: Snap on cover of .080" (2mm) thickness shall be extruded from chemical and stain resistant polyvinyl chloride with the addition of impact modifiers. No plasticizers shall be added.
 - b. Aluminum: Continuous aluminum retainer of .070-inch (1.8mm) thickness shall be fabricated from 6063-T5 aluminum, with a mill finish.
 - c. Cover Thickness: .080-inches (2mm).
 - d. Retainer: 0.070" thickness continuous extruded aluminum retainer

01-17-2022

4. Components:
 - a. Top Caps shall be made of injection molded thermoplastics.
 - b. Fasteners: All mounting system accessories appropriate for substrates indicated on the drawing shall be provided.
5. Finishes:
 - a. Color of Vinyl Covers: As scheduled.
 - b. Corner Guard Retainer: Retainer color shall be mill finish.
 - c. Molded components: Top Caps shall be of a color matching the corner guards. Surface shall have a pebblette texture.
6. Performance Requirements:
 - a. Surface Burning Characteristics: Provide assemblies with flame spread index of 10 and smoke developed index of 350-450, when tested in accordance with ASTM E84.
 - b. Fire Resistance: Where fire rating is specified for the wall in which the guard is mounted, provide assemblies that have been tested in accordance with ASTM E119 for the same rating as the wall.
 - c. Self-Extinguishing: Provide corner guards with a CC1 classification, as tested in accordance with the procedures specified in ASTM D635.
 - d. Resist lateral impact force of 100 lbs (445 N) at any point without damage or permanent set.
 - e. Support vertical live load of 100 lb/lineal ft (1,400 N/m) with deflection not to exceed 1/50 of span between supports.
 - f. Impact Strength: 30.2 ft-lbs/inch of thickness as tested in accordance with the procedures specified in ASTM D256.
 - g. Chemical and stain resistance: Provide wall protection system components with chemical and stain resistance in accordance with ASTM D543.
 - h. Fungal and Bacterial Resistance: Provide rigid vinyl that does not support fungal or bacterial growth as tested in accordance with ASTM G21.

2.04 FABRICATION

- A. Fabricate components with tight joints, corners and seams.
- B. Form end trim closure by capping and finishing smooth.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.
- B. Verify that field measurements are as indicated on Drawings.

3.02 PREPARATION

- A. General: Prior to installation, clean substrate to remove dust, debris and loose particles.

3.03 INSTALLATION

- A. Install fabrications in accordance with shop drawings and manufacturer's instructions.
- B. Install panels with bottom edge located to clear top of wall base.
- C. Apply adhesive uniformly using adhesive manufacturers recommended trowel to the entire back of panels completely to the edge (100% coverage).
- D. Lay wall panels in place leaving approximately 1/8 inch between panels and 1/4 inch space top and bottom.
- E. Follow adhesive manufacturer's recommendations for set and application times.
- F. Apply pressure to entire panel face with laminate type roller, removing trapped air and ensure proper adhesion between surfaces.

3.04 INSTALLATION - CORNER GUARDS

- A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to wall framing members only.

- B. Position corner guard at the top of the wall base. Terminate at finished ceiling height.

3.05 CLEANING

- A. At completion of the installation, clean surfaces in accordance with the manufacturer's instructions.

END OF SECTION 10 26 13

**SECTION 10 28 00
TOILET ACCESSORIES**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Public-use washroom accessories.
- B. Private-use washroom accessories.
- C. Custodial room accessories.

1.03 RELATED SECTIONS

- A. Section 06 10 00 - Rough Carpentry
- B. Section 09 21 16 - Gypsum Board Assemblies
- C. Section 09 30 00 - Tiling
- D. Section 09 91 23 - Interior Painting
- E. Section 08 83 13 - Frameless Mirrors

1.04 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- B. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service 2015a (Reapproved 2019).
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- E. ASTM B456 - Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium 2017.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures, for additional requirements.
- B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.
- C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required. Use room and product designations indicated on Drawings.
- D. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum five years documented experience producing products specified.
- B. Source Limitations: To the greatest extent possible products shall be provided by a single manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Ship products in manufacturer's standard protective packaging with vinyl coating on exposed surfaces.
- B. Storage and Protection: Store products in manufacturer's protective packaging until installation.

01-17-2022

1.08 SEQUENCING

- A. Supply locations, dimensions, and other pertinent details to installing Contractor for coordination of blocking, support and recess size and locations required for accessory installation.

1.09 WARRANTY

- A. Toilet Accessories: Manufacturer's standard 3-year warranty against defects in product workmanship and materials, beginning at the Date of Substantial Completion.
- B. Mirrors: Manufacturer's 15-year warranty against silver spoilage of mirrors, beginning at the Date of Substantial Completion.
- C. Hand Dryers: Manufacturer's standard 10-year warranty on materials and workmanship, beginning at the Date of Substantial Completion.
- D. Hair Dryers: Manufacturer's standard 10-year warranty on materials and workmanship, beginning at the Date of Substantial Completion.
- E. Baby Changing Station: Manufacturer's standard 5-year warranty on materials and workmanship, to include a provision for replacement caused by vandalism.
 - 1. Warranty Period: 5-years from the Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Specified Manufacturer: Bobrick Washroom Equipment.
 - 1. Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be acceptable.
 - a. A&J Washroom Accessories (P: 845-562-3332 / www.ajwashroom.com)
 - b. American Specialties, Inc. (P: 914-476-9000 / www.americanspecialties.com)
 - c. Bradley Corporation (P: 800-272-3539 / www.bradleycorp.com)

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.
 - 1. Grind welded joints smooth.
 - 2. Fabricate units made of metal sheet of seamless sheets, with flat surfaces.
- B. Keys: Provide 3 keys for each accessory to Owner; master key lockable accessories.
- C. Stainless Steel Sheet: ASTM A666, Type 304.
- D. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.
- E. Galvanized Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.
- F. Adhesive: Two component epoxy type, waterproof.
- G. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

2.03 FINISHES

- A. Stainless Steel: Satin finish, unless otherwise noted.
- B. Chrome/Nickel Plating: ASTM B456, SC 2, polished finish, unless otherwise noted.
- C. Baked Enamel: Pretreat to clean condition, apply one coat primer and minimum two coats epoxy baked enamel.
- D. Galvanizing for Items Other than Sheet: Comply with ASTM A123/A123M; galvanize ferrous metal and fastening devices.
- E. Shop Primed Ferrous Metals: Pretreat and clean, spray apply one coat primer and bake.
- F. Back paint components where contact is made with building finishes to prevent electrolysis.

2.04 ACCESSORY SCHEDULE

- A. Washroom Accessories, scheduled on the drawings as Finish Type TA-XX.
 - 1. Refer to the Sheet A0.5) for the "Toilet Accessory Schedule".
- B. Type TA-01: MIRRORS (FRAMED):
 - 1. Product: Bobrick; Model B-165 Mirror with stainless steel channel frame:
 - a. Description: Mirror shall have a one-piece type-430 stainless steel channel frame, with 90° mitered corners; all exposed surfaces shall have bright polished finish. Select float glass mirror shall be guaranteed for 15 years against silver spoilage. The back shall be protected by full-size, shock-absorbing, water-resistant, nonabrasive, polyethylene padding. Galvanized steel back shall have integral horizontal hanging brackets located at top and bottom for mounting on concealed wall hanger to prevent the mirror from pulling away from the wall. Locking devices secure mirror to concealed wall hanger. Mirror shall be removable from the wall.
 - 2. Mirror Sizes: As indicated on the drawings.
 - 3. Mounting Heights:
 - a. Mirrors above lavatories: 40-inches (maximum) above finished floor to bottom of reflecting surface.
- C. Type TA-02: PAPER TOWEL DISPENSER, SMALLER CAPACITY:
 - 1. Product: Bobrick; Model B-2621:
 - a. Description: Surface-mounted paper towel dispenser shall be type-304 stainless steel with all-welded construction; exposed surfaces shall have satin finish. Door shall be secured to cabinet with a full-length stainless steel piano-hinge and equipped with a knob latch. Paper towel tray shall have hemmed opening to dispense paper towels without tearing. Unit shall be capable of dispensing 200 C-fold or 275 multifold paper towels.
 - 2. Mounting Height: 47-inches above finished floor to top of unit.
- D. Type TA-03: LIQUID SOAP DISPENSER:
 - 1. Product: Bobrick; Model B-42:
 - a. Description: Soap dispenser shall have black, high-impact-resistant ABS wall bracket, lid, push button, and spout. Bracket shall be equipped with a locking device to secure lid, container, and a removable plastic key to disengage locking device. Vandal-resistant lid shall pivot up for top filling only after lock is disengaged. Corrosion-resistant valve shall have soap head-holding mushroom valve, stainless steel spring, U-packing seal, and duckbill; and shall dispense commercially marketed all-purpose hand soaps. Valve shall be operable with one hand and with less than 5 pounds of force (22.2 N) to comply with accessible design (including ADAAG in U.S.A.). Container shall be black, translucent ABS with a capacity of 40-fl oz (1.2-L), be retained to the wall bracket by a sliding latch and a container stop spring tab and shall be removable for maintenance or replacement.
 - 2. Mounting Height:
 - a. Above Base Cabinets: 42-inches above finished floor to bottom of unit.
 - b. At Lavatories: 50-inches above finished floor to top of unit.
- E. Type: TA-04: GRAB BAR - REAR WALL:
 - 1. Product: Bobrick; Model B-6806 Series Grab Bar:
 - a. Description: Grab bar shall be type-304 stainless steel with satin-finish. Grab bar shall have 18-gauge (1.2mm) wall thickness and 1-1/2 inch (38mm) outside diameter. Clearance between the grab bar and wall shall be 1-1/2 inches (38mm). Concealed mounting flanges shall be 11-gauge (3.2mm) thick stainless steel plate, 2-inches x 3-1/8 inches (50 x 80mm), and equipped with at least two screw holes for attachment to wall. Flange covers shall be 22 gauge (0.8mm), 3-1/4 inch (85mm) diameter x 1/2-inch (13mm) deep, and shall snap over mounting flange to conceal mounting screws and/or fasteners. Ends of grab bar shall pass through concealed mounting flanges and be heliarc welded to form one structural unit. Grab bar shall comply with accessible design for structural strength.

01-17-2022

2. Performance: Push/Pull Point Load: Install grab bars to withstand downward force of not less than 250 lbs, per ASTM F446.
3. Configuration and Length: Horizontal, 36-inches.
4. Mounting Height: 36-inches above finished floor to top of grab bar.
5. Location: Located 12-inches from the center of the water closet on one side and 24-inches on the other side.

F. Type TA-05: GRAB BAR - SIDEWALL

1. Product: Bobrick; Model B-6806 Series Grab Bar:
 - a. Description: Grab bar shall be type-304 stainless steel with satin-finish. Grab bar shall have 18-gauge (1.2mm) wall thickness and 1-1/2 inch (38mm) outside diameter. Clearance between the grab bar and wall shall be 1-1/2 inches (38mm). Concealed mounting flanges shall be 11-gauge (3.2mm) thick stainless steel plate, 2-inches x 3-1/8 inches (50 x 80mm), and equipped with at least two screw holes for attachment to wall. Flange covers shall be 22 gauge (0.8mm), 3-1/4 inch (85mm) diameter x 1/2-inch (13mm) deep, and shall snap over mounting flange to conceal mounting screws and/or fasteners. Ends of grab bar shall pass through concealed mounting flanges and be heliarc welded to form one structural unit. Grab bar shall comply with accessible design for structural strength.
2. Performance: Push/Pull Point Load: Install grab bars to withstand downward force of not less than 250 lbs, per ASTM F446.
3. Configuration and Length: Horizontal, 42-inches.
4. Mounting Height: 36-inches above finished floor to top of grab bar.
5. Location: Located 12-inches from the rear wall to the flange centerline.

G. Type TA-06: GRAB BAR - VERTICAL

1. Product: Bobrick; Model B-6806 Series Grab Bar:
 - a. Description: Grab bar shall be type-304 stainless steel with satin-finish. Grab bar shall have 18-gauge (1.2mm) wall thickness and 1-1/2 inch (38mm) outside diameter. Clearance between the grab bar and wall shall be 1-1/2 inches (38mm). Concealed mounting flanges shall be 11-gauge (3.2mm) thick stainless steel plate, 2-inches x 3-1/8 inches (50 x 80mm), and equipped with at least two screw holes for attachment to wall. Flange covers shall be 22 gauge (0.8mm), 3-1/4 inch (85mm) diameter x 1/2-inch (13mm) deep, and shall snap over mounting flange to conceal mounting screws and/or fasteners. Ends of grab bar shall pass through concealed mounting flanges and be heliarc welded to form one structural unit. Grab bar shall comply with accessible design for structural strength.
2. Performance: Push/Pull Point Load: Install grab bars to withstand downward force of not less than 250 lbs, per ASTM F446.
3. Configuration and Length: Vertical, 18-inches.
4. Mounting Height: 40-inches above finished floor to the centerline of the bottom flange.
5. Location: Located 40-inches from the rear wall to the centerline of the unit.

H. Type TA-08: TOILET TISSUE DISPENSER:

1. Product: Bobrick; Model No.B-2840, Double Roll, Surface-Mounted Toilet Tissue Dispenser and Utility Shelf:
 - a. Description: Surface-mounted toilet tissue dispenser and utility shelf shall be type-304 stainless steel with satin finish. Shelf shall have 1/2" (13mm) return edges with front edge hemmed for safe handling. Provide theft-resistant spindles (Part No. 283-604) to hold standard-core toilet tissue rolls up to 5-1/2 inch (140mm) diameter (1800 sheets).
 - b. Utility Shelf Size: 16-inches long X 5-inches deep.
2. Mounting Height and Location: 22-inches above finished floor to top of shelf.
3. Location: Located 7- to 9-inches from the front face of the water closet to the center of the first roll of toilet paper for the dual roll unit.

I. Type TA-09: SANITARY NAPKIN DISPOSAL UNIT:

1. Product: Bobrick; Model B-270, Surface-Mounted Sanitary Napkin Disposal Unit:

- a. Description: Surface-mounted sanitary napkin disposal shall be type-304 stainless steel with all-welded construction; exposed surfaces shall have satin finish. Cover shall be drawn, one-piece, seamless construction and secured to container with a full-length stainless steel piano-hinge. Container shall have integral finger depression for opening cover.
 2. Mounting Height: 30-inches above finished floor to top of unit.
 3. Location: Align side of unit with the front edge of the toilet or water closet.
- J. Type TA-27: PAPER TOWEL DISPENSER, LARGE CAPACITY:
1. Product: Bobrick; Model B-262:
 - a. Description: Surface-mounted paper towel dispenser shall be type-304 stainless steel with all-welded construction; exposed surfaces shall have satin finish. Door shall be secured to cabinet with a full-length stainless steel piano-hinge and equipped with a tumbler lock keyed like other Bobrick washroom accessories. Paper towel tray shall have hemmed opening to dispense paper towels without tearing. Unit shall be capable of dispensing 400 C-fold or 525 multifold paper towels.
 2. Mounting Height: 54-inches above finished floor to top of unit.
- K. Type TA-33: UTILITY SHELF WITH MOP/BROOM HOLDERS:
1. Product: Bobrick; Model B-239, Utility Shelf with Mop / Broom Holders and Rag Hooks.
 - a. Description: Utility shelf with mop/broom holders and rag hooks shall be type-304 stainless steel with all-welded construction; exposed surfaces shall have satin finish. Shelf shall be 18 gauge (1.2mm), 8-inches (205mm) deep with 3/4-inch (19mm) return edges, and shall have front edge hemmed for safety.
 - 1) Mop/Broom Holders: Spring-loaded rubber cams with anti-slip coating. Plated steel retainers. Three (3) required.
 - 2) Hooks: 18-8, type-304, 12-gauge (2.8mm) stainless steel with satin finish. Each hook attached to mounting strip with two rivets. Four (4) required.
 2. Length: 34-inches (865 mm) .
 3. Mounting Height: 72-inches above finished floor to top of shelf.
- L. Type TA-36: DUAL-ROLL TOILET TISSUE DISPENSER WITH CONTROLLED DELIVERY:
1. Product: Bobrick; Model No. B-265, Double-Roll Toilet Tissue Dispenser with Controlled Delivery:
 - a. Description: Double-roll toilet tissue dispenser shall be heavy-gauge chrome-plated steel with bright polished finish. Unit shall be equipped with vandal-resistant self-locking mechanisms, provide controlled delivery operation, and accommodate two standard-core toilet tissue rolls up to 4-1/2 inch (115mm) diameter.
 2. Mounting Height and Location: 19-inches above finished floor to centerline of the spindles.
 3. Location: Located 7- to 9-inches from the front face of the water closet to the center of the first roll of toilet paper for the dual roll unit.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation. Coordinate with Owner.
- C. For electrically-operated accessories, verify that electrical power connections are ready and in the correct locations.

3.02 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on the drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.

- C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.

3.04 PROTECTION

- A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION 10 28 00

**SECTION 10 44 00
FIRE PROTECTION SPECIALTIES**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets and accessories.

1.03 RELATED SECTIONS

- A. Section 06 10 00 - Rough Carpentry.
- B. Section 09 91 23 - Interior Painting.

1.04 REFERENCE STANDARDS

- A. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable 2021a.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- C. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
- D. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.
- E. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).
- F. FM (AG) - FM Approval Guide current edition.
- G. NFPA 10 - Standard for Portable Fire Extinguishers 2017, with Errata (2018).
- H. UL (DIR) - Online Certifications Directory Current Edition.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures, for additional requirements.
- B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection cabinets.
 - 1. Fire Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
- C. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.06 QUALITY ASSURANCE

- A. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.
- B. Provide fire protection specialties produced by a single manufacturer.
- C. Provide fire extinguishers of type approved by UL, State Fire Marshal's Office, and local regulatory agencies, if any.

1.07 COORDINATION

- A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate size of fire protection cabinets to ensure that type and capacity of fire hoses, hose valves, and hose racks indicated are accommodated.
- C. Coordinate sizes and locations of fire protection cabinets with wall depths.

1.08 WARRANTY

- A. Fire Extinguishers: The manufacturer shall warrant the product/s to be free of defects in material and workmanship under conditions of normal use for a period of six (6) years from Date of Substantial Completion.
- B. All Fire Protection Products (except fire extinguishers) carry a one year warranty from the Date of Substantial Completion against defects in materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Specified Manufacturer/s:
 - 1. Fire Extinguishers: J.L. Industries.
 - a. Contacts: P: (800) 554-6077 / Email: sales@activarcpg.com / Web: www.activarcpg.com
 - 2. Fire Extinguisher Cabinets: Larsen's Manufacturing Company.
 - a. Contacts: P: (800) 527-7367 / Web: www.larsensmfg.com
- B. Other Acceptable Manufacturer: Equivalent products of the manufacturer's listed below will be acceptable.
 - 1. Kidde (United Technologies).
 - 2. Ansul (Tyco).
 - 3. Nystrom, Inc.
 - 4. Potter-Roemer.
 - 5. Pyro-Chem (Tyco).

2.02 MATERIALS

- A. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.
 - 1. Thickness: 0.036 inches, minimum.
 - 2. Finish: Baked enamel paint finish.
 - 3. Color: As selected by Architect.
- B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet according to ASTM A653/A653M, G90 (Z275) coating designation.
- C. Aluminum: ASTM B221 (ASTM B221M), with strength and durability characteristics of not less than Alloy 6063-T5 for aluminum sheet, 0.063 inch (1.6 mm) thick.
 - 1. Finish: Baked enamel paint finish.
 - 2. Color: Light bronze or As selected by Architect from Manufacturer's standard colors.

2.03 FIRE EXTINGUISHERS

- A. 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. Fire Extinguisher, Type A:
 - 1. Multi-Purpose Chemical Type: Extinguisher unit containing a fluidized and siliconized mono ammonium phosphate powder; nonconductive and nontoxic.
 - 2. Product: JLI; Cosmic Series, Model 10E
 - a. Nominal Capacity: 10 pound (4.54 kg)

01-17-2022

- b. Construction: Heavy duty steel cylinder with metal valve and siphon tube, O-ring seal, replaceable valve stem seal, visual pressure gage, pull pin and upright squeeze grip.
 - c. Finish: Factory powder-coated; Red.
 - d. Effectiveness (Rating): Class A, B, and C fires.
 - e. UL Rating: 4A-80B:C.
 - f. Size: 5-inch diameter / 21-inches high.
- C. Fire Extinguisher, Type K:
 - 1. Class K Wet Chemical Type: Extinguisher unit containing a low "pH" potassium acetate solution.
 - 2. Product: JLI; Saturn Series, Model 15.
 - a. Size: 1.8 gallons (6.8 L).
 - b. Construction: Stainless steel cylinder with protective nozzle tip orifice seal and nonmetallic nozzle tip finger guard, O-ring seal, replaceable valve stem seal, visual pressure gage, pull pin, and upright squeeze grip.
 - c. Effectiveness (Rating): Class A, K fires.
 - d. UL Rating: (C)1-A:K.
 - e. Size: 7-inch diameter / 19-1/4 inches overall height.

2.04 SEMI-RECESSED FIRE PROTECTION CABINETS

- A. General Specifications:
 - 1. Cabinet Configuration: Semi-recessed type.
 - a. Sized to accommodate accessories.
 - b. Interior Dimensions of Cabinets: 9-1/2 inches wide by 24-inches high by 6-inches deep, typical unless noted otherwise.
 - c. Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.
 - d. Provide cabinet enclosure with right angle inside corners and seams, and with formed perimeter trim and door stiles.
 - 2. Cabinet Box:
 - a. Non-Fire-Rated Cabinets:
 - 1) Formed 0.036 inch (0.9 mm) thick steel sheet with white baked enamel finish.
 - b. Fire-Rated Cabinets:
 - 1) Construction: Shall have double wall of formed 0.036 inch (0.9 mm) thick steel sheet with white baked enamel finish. The space between the double walls shall be lined with 5/8 inch (15.9 mm) thick fire barrier material.
 - 2) Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.
 - 3. Cabinet Exterior Trim and Door:
 - a. Material: Type 304 stainless steel with a #4 finish.
 - b. Door Style: Vertical Duo.
 - c. Door Glazing:
 - 1) Tempered glass, clear, 1/8 inch (3 mm) thick, and set in resilient channel glazing gasket.
 - d. Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
 - 1) Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch (13 mm) thick.
 - 2) Fabricate door frames of one-piece construction with edges flanged.
 - 3) Miter and weld perimeter door frames.
 - 4. Door Hardware:
 - a. Catch: Self-adjusting roller catch.
 - b. Hinge: Continuous piano hinge capable of opening 180-degrees.
 - c. Door Pull: Satin finish pull handle.
 - 5. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.

- B. Non-Rated Semi-Recessed Cabinet, Type FEC:
 - 1. Product: Larsen's; "Architectural Series", Model No. 2409-6R.
 - 2. For installation in non-rated wall construction.
 - 3. Fire Extinguisher: Provide one (1) fire extinguisher, Type A.
 - 4. Cabinet trim projection from wall: 2-1/2 inches, rolled edge.
 - 5. Rough Opening Depth: 4-inches, minimum. Coordinate with wall construction for proper clearance.

2.05 SOURCE QUALITY CONTROL

- A. Ship extinguishers to the Project site fully charged, EXCEPT those which contain water as an extinguishing agent, if any.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where recessed and semi-recessed cabinets will be installed, and blocking where surface mounted cabinets will be installed.
 - 1. Notify the Contractor in writing of conditions detrimental to proper and timely completion of the installation.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install cabinets in locations and at mounting heights indicated, or if not indicated, at heights to comply with applicable regulations of governing authorities.
 - 1. Prepare recesses in walls for fire extinguisher cabinets as required by type and size of cabinet and style of trim and to comply with manufacturer's instructions.
 - 2. Securely fasten mounting brackets and fire extinguisher cabinets to structure, square and plumb, to comply with manufacturer's instructions.
 - 3. Maintain fire ratings where cabinets are recessed into fire-rated wall systems.

3.03 FIELD QUALITY CONTROL

- A. Ensure that each extinguisher is fully charged, and that inspection of each extinguisher has been performed, as evidenced by the National Association of Fire Equipment Distributors certification tag, just prior to turnover.

END OF SECTION 10 44 00

**SECTION 10 51 00
LOCKERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal lockers.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry: Wood base construction.
- B. Section 06 10 00 - Rough Carpentry: Wood blocking and nailers.

1.03 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's published data on locker construction, sizes and accessories.
- C. Shop Drawings: Indicate locker plan layout, numbering plan.

PART 2 PRODUCTS

2.01 LOCKER APPLICATIONS

- A. ICU Locker Room: Three tier metal lockers, wall mounted with matching closed base.
 - 1. Width: 12 inches (300 mm).
 - 2. Depth: 12 inches (300 mm).
 - 3. Height: 72 inches (1,830 mm).
 - 4. Fittings: Hat shelf, 2 coat hooks.
 - 5. Locking: Padlock hasps, for padlocks provided by Owner.

2.02 METAL LOCKERS

- A. Lockers: Factory assembled, made of formed sheet steel, ASTM A653/A653M SS Grade 33/230, with G60/Z180 coating, stretcher leveled; metal edges finished smooth without burrs; baked enamel finished inside and out.
 - 1. Color: To be selected by Architect; allow for contrasting colors for locker bodies and doors.
- B. Locker Body: Formed and flanged; with steel stiffener ribs; electric spot welded.
 - 1. Body and Shelves: 24 gage, 0.0239 inch (0.61 mm).
- C. Frames: Formed channel shape, welded and ground flush, welded to body, resilient gaskets and latching for quiet operation.
 - 1. Door Frame: 16 gage, 0.0598 inch (1.52 mm), minimum.
- D. Doors: Hollow double pan, sandwich construction, 1-3/16 inch (30 mm) thick; welded construction, channel reinforced top and bottom with intermediate stiffener ribs, grind and finish edges smooth.
 - 1. Door Outer Face: 18 gage, 0.0478 inch (1.21 mm), minimum.
 - 2. Door Inner Face: 20 gage, 0.0359 inch (0.91 mm), minimum.
 - 3. Form recess for operating handle and locking device.
 - 4. Provide louvers in door face, top and bottom, for ventilation.
- E. Hinges: Two for doors under 42 inches (1050 mm) high; three for doors over 42 inches (1050 mm) high; weld securely to locker body and door.
 - 1. Hinge Thickness: 14 gage, 0.0747 inch (1.90 mm).
- F. Number Plates: Provide oval shaped brass plates. Form numbers [] inch ([] mm) high of block font style with ADA designation, in contrasting color.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that prepared bases are in correct position and configuration.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install lockers plumb and square.
- C. Place and secure on prepared base.

3.03 CLEANING

- A. Clean locker interiors and exterior surfaces.

END OF SECTION 10 51 00

SECTION 12 32 16
MANUFACTURED PLASTIC LAMINATE FACED CASEWORK

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Fixed modular plastic laminate clad casework and components.
- B. Plastic laminate countertops .
- C. Utility Shelving.

1.03 RELATED SECTIONS

- A. Section 06 10 00 - Rough Carpentry
- B. Section 06 61 16 - Solid Surface Fabrication
- C. Section 09 21 16 - Gypsum Board Assemblies
- D. Section 09 91 23 - Interior Painting
- E. Division 22 - Plumbing
- F. Division 26 - Electrical

1.04 REFERENCES

- A. AWI Section 400 (Architectural Cabinets)

1.05 DEFINITIONS

- A. Definitions in the AWI/AWMAC/WI's "Architectural Woodwork Standards" apply to the Work of this Section.
- B. Manufactured Plastic Laminate Faced Casework (from here on referred to as "Casework") shall refer to laminated plastic casework, cabinets, shelving, counter, counters, related hardware and items indicated on the Drawings and specified.
- C. NEMA LD3 - High Pressure Decorative Laminates (HPDL) Grades:
 - 1. Grade HGS (GP 50): Horizontal grade
 - 2. Grade VGS (GP-28): Vertical Grade
 - 3. Grade CLS (CL 20): Cabinet liner
 - 4. Grade BKL (BK 20): Backing sheet
- D. TFM: Thermally Fused Melamine-Clad Particleboard.
- E. LPDL: Low-Pressure Decorative Laminate.
- F. MDF: Medium Density Fiberboard.
- G. MR MDF: Moisture-Resistant MDF.

1.06 COORDINATION

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

1.07 QUALITY ASSURANCE

- A. Manufacturer: Minimum of 5 years experience in providing manufactured casework systems for similar types of projects, produce evidence of financial stability, bonding capacity, and adequate facilities and personnel required to perform on this project.
- B. Manufacturer: Provide products certified as meeting or exceeding ANSI-A 161.1-2000 testing standards.

01-17-2022

- C. Single Source Manufacturer: Casework, countertops and architectural millwork products must all be engineered and built by a single source manufacturer in order to ensure consistency and quality for these related products. Splitting casework, countertops and/or architectural millwork between multiple manufacturers will not be permitted.
- D. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- E. Quality Standard: AWI standards are used to establish the minimum standard for casework construction to be provided on the project. AWI Section 400 (Architectural Cabinets) shall apply unless the Contract Documents specifies otherwise.
 - 1. Provide labels and certificates from AWI certification program indicating that casework, including installation, complies with requirements of grades specified.
 - 2. The following specifications are based on laminated plastic casework which shall be "Premium" grade as indicated and defined by the American Woodworking Institute (AWI).

1.08 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop drawings: Include plans, elevations, sections, details, and attachments to other work. Approved shop drawings and field verifications shall be obtained prior to fabrication.
- C. Keying Schedule: Include keying chart indicating whether cabinets, by room, are keyed alike or keyed differently and the quantity of master keys required.
- D. Samples for Verification: For the following:
 - 1. Laminate for each pattern selected.
 - 2. PVC edging for each pattern selected.
 - 3. Thermally fused melamine for each pattern selected.
 - 4. Hardware for each finish selected.
 - 5. Cabinet Sample: Submit full size, production type sample of a plastic laminate base cabinet showing complete construction details in accordance with the Contract Documents. Sample shall include one drawer, one shelf, service fittings, cabinet hardware, and a countertop.
 - a. Sample shall be delivered within 30 calendar days from contract date, at no cost to the Architect or Owner. Miniature "show room" type samples are not acceptable.

1.09 DELIVERY, STORAGE AND HANDLING

- A. Deliver casework only after painting, utility roughing-in, and similar operations that could damage, soil, or deteriorate casework have been completed in installation areas. If casework must be stored in other than installation areas, store only in areas where environmental conditions meet minimum requirements for building conditioning for installation of finishes.
- B. Keep finished surfaces covered with polyethylene film or other protective covering during handling and installation.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install casework 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. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.
- C. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.11 WARRANTY

- A. Special Manufacturer's Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.

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1. Failures include, but are not limited to, the following:
 - a. Delamination of components or other failures of glue bond.
 - b. Warping of components.
 - c. Failure of operating hardware.
2. Warranty Period: One (1) year from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Manufacturer: Casework products from Advanced Cabinet Systems (ACS) are specified to establish a standard of quality for design, function, materials, and appearance.
 1. Other Manufacturers: The following manufacturers are approved to provide materials or products that are equivalent to the "Basis of Design":
 - a. Precision Millwork
 - b. Creative Associates
 - c. Stevens Industries
 - d. LSI Corporation
 - e. Case Systems
 - f. TMI Systems Corporation
 - g. FADCO
- B. Substitutions: See Section 01 25 00.
 1. Approved equal does not imply acceptance of that manufacturer's "standard" construction and/or materials. Materials and construction shall comply in minimum with the AWI standards.

2.02 CASEWORK - GENERAL

- A. Quality Standard: Perform work to meet the requirements of 'Premium' Grade in accordance with the "Architectural Woodwork Standards (AWS)".
- B. Design:
 1. Cabinet Style:
 - a. Flush overlay with concealed hinges.
- C. Cabinet Grain Direction for Wood Grain Plastic Laminate:
 1. Vertical on door and drawer fronts with continuous vertical matching.
 2. Vertical on end panels.
 3. Side-to-side on bottoms and tops of units.
 4. Vertical on knee-space panels.
 5. Horizontal on aprons.

2.03 MATERIALS

- A. Lumber shall be in accordance with the AWS Grade specified for the product being fabricated. Moisture content shall be 6% to 12% for boards up to 2-inches nominal thickness, and shall not exceed 19% for thicker pieces.
- B. Particle Board: ANSI A208.1, Mat-Formed Particle Board, Grade M-2.
 1. Type: Particleboard with ultra-low emitting formaldehyde resins (ULEF).
 2. Sustainability: Carb II Compliant.
 3. Density: 45-pound, minimum.
 4. Internal Bond: 60 psi.
 5. Screw Holding Capacity: 225 lb. on faces and 200 lb. on edges, minimum.
- C. Hardboard: ANSI A135.4, Class 1, Tempered.
- D. Decorative Laminates: Shall be High Pressure Decorative Laminate (HPDL):
 1. Standards Compliance: NEMA LD 3, and ANSI A161.2 .
 2. Grades:
 - a. VGS: Vertical Grade, 0.028-inches thick.
 - b. HGS: Horizontal Grade, 0.048-inches thick.

01-17-2022

- c. HGP: Horizontal Grade, Post-formed, 0.039-inches thick.
 - d. VGP: Vertical Grade, Post-Formed, 0.028-inches thick.
 - e. HGF: Horizontal application, fire retardant material.
 - f. VGF: Vertical application, fire retardant material.
 - g. CLS: Cabinet Liner, 0.020-inches thick.
 - h. BKH: Backer, 0.020-inches thick.:
 - i. TFM: Thermally Fused Melamine Laminate Panels: Particleboard or MDF finished with 100-gram (minimum) thermally fused, melamine-impregnated decorative paper, and complying with requirements of NEMA LD 3, Grade VGL for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10. Finish shall be resistant to water and mild cleaners.
- E. Medium Density Fiberboard (MDF):
- 1. Composition: Lignocellulosic fibers and no-added formaldehyde synthetic resin.
 - 2. ANSI A208.2 compliant, Grade 130.
- F. Moisture-Resistant MDF (MR-MDF): Where countertops receive sinks, lavatories, or are subjected to liquids:
- 1. Basis of Design: "Medex", as manufactured by Roseburg Forest Products Company.
 - a. Standards Compliance:
 - 1) ANSI A208.2 - Grade 155; MR50.
 - 2) ASTM D1037-06a: Passed the 6-Cycle Accelerated Aging Test.
 - 3) ASTM E84, Class C flame spread rating.
 - b. Density: 48 pcf, minimum.
- G. Edgebanding: Refer to "Edgebanding" Article this Section.
- H. Adhesives: Chemical-resistant waterproof adhesive as recommended by manufacturer of materials being joined.
- 1. Do not use adhesives that contain urea formaldehyde.
- I. Joint Sealant: Mildew-resistant silicone sealant, white.

2.04 SURFACES

- A. Exposed Surfaces (Closed Interiors): Any closed storage unit behind solid door or drawer fronts. Surfaces visible when doors and drawers are closed, include:
- 1. Door and Drawer Fronts; Exterior Faces: HPDL, Grade VGS.
 - 2. Exposed Ends: Any storage unit exterior side surface that is visible after installation: HPDL, Grade VGS.
 - 3. Exposed Bottoms of Wall Cabinets:
 - a. 48-inches or more above finished floor: HPDL, Grade VGS.
 - b. Less tha 48-inches above finished floor: HPDL , Grade HGS.
 - 4. Exposed Tops of Wall Cabinets, Tall Cabinets, and Hutches:
 - a. 80-inches or taller and not visible from above: HPDL, Grade VGS.
 - b. Less than 80-inches tall or visible from above: HPDL, Grade HGS.
 - 5. Edges: Refer to "Edgebanding" Article this Section.
- B. Open Interiors: Any open storage unit without solid door or drawer fronts, units with full glass insert doors and/or acrylic doors, and units with sliding solid doors.
- 1. Open Cabinet Interior (Top, bottom, back sides, horizontal and vertical members): HPDL, Grade VGS.
 - 2. Open Cabinet Shelving: HPDL, Grade VGS.
 - 3. Edges: Refer to "Edgebanding" Article this Section.
- C. Semi-Exposed Surfaces: Surfaces behind opaque doors that are exposed, including:
- 1. Door and Drawer Fronts - Interior: HPDL, Grade VGS.
 - a. Color: Same color as cabinet interior.
 - 2. Cabinet Interior (Top, bottom, back sides, horizontal and vertical members): HPDL, Grade TFM; Color shall be White.
 - 3. Edges: Refer to "Edgebanding" Article this Section.

- D. Concealed Surfaces: Surfaces that are not visible after installation, including sleepers, web frames, dust panels, and ends and backs that are placed directly against walls or other cabinets; HPDL, Grade TFM, CLS, or BKH at Manufacturer's Option.
- E. Toekicks: Resilient base (by others).
- F. Wall Shelving on Standards and Brackets: HPDL, Grade HGS.
 - 1. Edges: Refer to "Edgebanding" Article this Section.
- G. Drawer Boxes: Clear Finish or Metabox (Contractor Option).

2.05 EDGEBANDING

- A. Material: Rigid PVC extrusion; through color with satin finish.
- B. Edge Banding Thickness:
 - 1. Cabinet Edges: 1-mm PVC.
 - 2. Door and Drawer Fronts: 3-mm PVC.
 - 3. Semi-Exposed Adjustable Shelves: 3-mm PVC, Front edge only.
 - 4. Exposed Adjustable Shelves: 3-mm PVC, Front edge only.
 - 5. Tops of Wall Cabinets, Tall Cabinets, and Hutches: 1-mm PVC.
 - 6. Wall Shelving (Standards & Brackets): 3-mm PVC, All four edges.
 - 7. Countertop: Refer to "Plastic Laminate Countertops" Article this Section.
- C. Color/s: Match scheduled plastic laminate materials.

2.06 CASEWORK FABRICATION

- A. Casework Construction: As required by referenced quality standard and the following:
- B. Cabinet Body Construction:
 - 1. General: Balanced construction of all laminated panels is mandatory. Unfinished core stock surfaces, even on concealed surfaces (excluding edges), are not permitted.
 - 2. Tops, Bottoms and Side Panels:
 - a. Core Material (Typical): 3/4-inch thick particleboard core with HPDL or TFM finish depending on the exposure.
 - 1) Exception: Sink Cabinets: Core shall be 3/4-inch thick Moisture-Resistant MDF (MR-MDF) with HPDL or TFM finish depending on the exposure.
 - b. Side panels and vertical dividers shall receive adjustable shelf hardware at 32mm line boring centers. Mount door hinges, drawer slides and pull-out shelves in the line boring for consistent alignment.
 - c. Edgebanding: Refer to "Edgebanding" Article this Section.
 - 3. Back Panels:
 - a. Closed Cabinets: 1/2-inch thick particleboard core with HPDL or TFM finish depending on the exposure.
 - 1) Core Material (Typical): 1/2-inch thick particleboard core with TFM finish.
 - (a) Exception: Sink Cabinet shall be 1/2-inch thick Moisture-Resistant MDF (MR-MDF) with TFM finish depending on the exposure.
 - 2) Back shall be dadoed into sides, bottoms, and tops of closed cabinets.
 - b. Open Cabinets: 3/4-inch thick particleboard core with HPDL finish.
 - 1) Back shall be dowelled into sides, bottoms, and tops of open cabinets.
 - 4. Cabinet Bases (Fixed base and tall units):
 - a. Material: 3/4-inch, 45 pound density particle board.
 - b. Height: 4-inches, unless noted otherwise.
 - c. Base Options:
 - 1) Individual factory-applied base.
 - 2) Separate Cabinet Bases (Contractor Option): Bases to be continuous per elevation with cross members on 16-inch centers.
 - 5. Base units, except sink base units: Full sub-top glued and doweled to cabinet sides.
 - a. Sink base units are provided with open top and a stretcher at the front, attached to the sides. Back to be split removable access panel.

01-17-2022

6. Adjustable Shelves in Cabinets:
 - a. All shelving shall be 1-inch thick particleboard core with HPDL finish.
 - b. All shelving shall be fully adjustable on 2-inch centers, with 5mm diameter holes.
 - c. Edgebanding: Refer to "Edgebanding" Article this Section.
- C. Door and Drawer Fronts:
 1. 3/4-inch particleboard core with HPDL finish.
 - a. Sink Cabinets: Core shall be Moisture-Resistant MDF (MR-MDF) with HPDL finish.
 2. Edgebanding: Refer to "Edgebanding" Article this Section.
- D. Drawers:
 1. Hardwood drawer bodies:
 - a. Drawer sides and back shall be 1/2-inch thick hardwood, fully dovetailed front, back and sides, with 1/4-inch thick tempered masonite bottoms.
 - b. Drawer bottom shall be 1/4-inch thick tempered masonite.
 - c. All exposed top, sides, bottoms and backs of wood and masonite to have factory finish of two (2) coats lacquer.
 2. CONTRACTOR OPTION: In lieu of hardwood drawers, provide steel drawer pans specified below:
 - a. Basis of Design Product: "Metabox", as manufactured by Blum, Inc. (P: 800-438-6788 / Web: www.blum.com)
 - b. Material / Finish: 0.0359-inch (0.9-mm-) thick metal, metallic phosphate treated, and finished with manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and 2 mils (0.05 mm) for system.
 - c. Drawer Configuration: Standard drawer.
 - d. Drawer Heights:
 - 1) Type N: 2-1/8 inches (54 mm)
 - 2) Type M: 3-3/8 inches (86 mm)
 - 3) Type K: 4-5/8" inches (118 mm) - Standard drawer height.
 - 4) Type H: 5-7/8 inches (150 mm)
 - e. Drawer Slide Operation: Self-Closing Action Drawer Slides (BLUMATIC) with full Extension Drawer Slides (330 Series).
 - f. Drawer Box Length: 21-5/8 inches.
 - g. Testing Standards: Meet or exceed ANSI/BHMA A156.9, Grade 1.
 - 1) Static load capacity: 100 lbs.
 - 2) Dynamic load capacity: 75 lbs.
 - 3) Test to perform 100,000 open/close cycles without failure.
- E. Filler Strips: Provide as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as cabinets.

2.07 JOINERY OF CASE BODY MEMBERS

- A. Tops, exposed ends and bottoms:
 1. Stop dado, glued with pressure, and either nailed, stapled or screwed (fasteners will not be visible on exposed parts), or
 2. Doweled, glued with pressure; approx. 4 per foot, or
 3. European assembly screws:
 - a. Fasteners are to be used no more than 37mm from each end, with subsequent screws no more than 128-mm on-center.
 - b. Screw heads and/or plastic trim caps shall not be visible on exposed parts.
 - c. Glue is not required with this system.
- B. Cabinet Backs - Wall-Mounted:
 1. Captured in grooves on cabinets sides and bottom; securely fastened.
- C. Cabinet backs - Floor-Standing:
 1. Side bound, captured in grooves; securely fastened to top and bottom.

01-17-2022

2.08 CABINET HARDWARE AND ACCESSORIES

- A. Hardware, General: Unless otherwise indicated, provide manufacturer's standard satin finish, stainless steel, or powder-coated, commercial-quality, heavy-duty hardware.
- B. Hinges:
 - 1. Frameless Concealed Hinges (European Type): BHMA A156.9, Type B01602, 120-degrees or 165-degrees of opening, self-closing.
 - a. Quantity:
 - 1) Provide two hinges for doors up to and including 36-inches high.
 - 2) Provide three hinges for doors over 36-inches, up to and including 54-inches high.
 - 3) Provide four hinges for doors over 54-inches up to and including 72-inches high.
 - 4) Provide five hinges for doors over 72-inches high.
- C. Metal Drawer and Door Pulls:
 - 1. Specified Manufacturer: Doug Mockett & Company (P: 800-523-1269 / Web: www.mockett.com)
 - a. Other Acceptable Manufacturer/s: Equivalent products of the manufacturer's listed below will be acceptable.
 - 1) Amerock (P: 800-435-6959 / Web: www.amerock.com)
 - 2) Rok Hardware
 - 3) GlideRite Hardware (P: 909-591-7555 / Web: www.gliderite.com)
 - 4) Jako Hardware (P: 786-899-0950 / Web: www.jako.biz)
 - 2. General:
 - a. Provide two pulls for drawers more than 27-inches wide.
 - b. Provide 1-inch long mounting screws.
 - 3. Metal Drawer and Door Pulls:
 - a. Product: Mockett; Model No. DP55A Rod Pull:
 - 1) Finish: Satin Stainless Steel.
 - 2) Length: 6-5/16 inches.
 - 3) Center-to-Center Spacing: 3-3/4 inches.
 - 4) Bar Diameter: 7/16-inches, nom.
 - 5) Post Diameter: 5/16-inches.
 - 6) Projection: 1-3/8 inches, nom.
 - 7) Meets ADA guidelines.
- D. Door Catches:
 - 1. Base and Wall Cabinets: Self-aligning, permanent magnetic catches.
 - 2. Tall Cabinets: Nylon-roller spring catch.
 - a. Provide two catches on doors more than 48-inches high.
- E. Door and Drawer Bumpers: Self-adhering, clear silicone rubber.
 - 1. Doors: Provide one bumper at top and bottom of closing edge of each swinging door.
 - 2. Drawers: Provide one bumper on back side of drawer front at each corner.
- F. Shelf Supports:
 - 1. Adjustable Shelf Supports: Two-pin locking plastic shelf rests complying with BHMA A156.9, Type B04013.
- G. Drawer Slides: BHMA A156.9, Grade 1HD-100:
 - 1. Box Drawer Slides:
 - a. Regular, kneespace and pencil drawers: 100-pound load rated epoxy coated steel, bottom corner mounted with smooth and quiet nylon rollers. Positive stop both directions with self-closing feature.
 - b. Paper storage drawers: 150-pound load rated epoxy coated steel slides.
 - 2. Letter/Legal File Drawer Slides: Full extension, 150-pound load rated epoxy coated steel, bottom corner mounted with smooth and quiet nylon rollers. Positive stop both directions with self-closing feature.

01-17-2022

- 3. Lateral File Drawer Slides, 30-inches and wider: Full extension, 200-pound load rated epoxy coated steel, bottom corner mounted with smooth and quiet nylon rollers. Positive stop both directions with self-closing feature.
- 4. File Suspension System: Extruded molding integral with top of file drawer box sides to accept standard hanging file folders.
- H. Sliding Door Track: Anodized aluminum double channel.
- I. Coat Rods: 1 inch diameter, 14-gauge chrome plated steel installed in captive mounting hardware.
- J. Mirrors: 1/8 inch thick mirrored acrylic, break and impact resistant.

2.09 DRAWER AND DOOR LOCKS

- A. Manufacturer: Products from Olympus Lock, Inc are specified to establish a standard of quality for design, function, materials, and appearance.
 - 1. Equivalent products by other manufacturers may be acceptable if approved in accordance with Section 01 25 00.
- B. Deadbolt Locks:
 - 1. Products:
 - a. Drawers: Olympus; N Series, Model No. 200DW.
 - 1) Compliance: ANSI/BHMA No. E07041
 - 2) Barrel Length: 15/16-inch, 1-3/8 inch, or 1-5/8-inch.
 - 3) Angle Strike: Olympus #12-3.
 - 4) Finish: US26D.
 - b. Doors: Olympus; N Series, Model No. 100DR.
 - 1) Compliance: ANSI/BHMA No. E07121.
 - 2) Barrel Length: 15/16-inch or 1-3/8 inch.
 - 3) Bar Strike: Olympus #56-1.
 - 4) Finish: US26D.
 - 2. General Specifications:
 - a. Rekeyable Deadbolt Locks. All locks to include working cylinder slides and forwardly removable cylinders for rekeying without totally disassembling lock body.
 - b. Standard Function: Key removable in locked or unlocked position. Standard function locks are non-handed.
 - c. Keyways:
 - 1) Standard Keying: N Series, National D4291, 4-pin system
 - 2) Masterkeyed: N Series, National D4292, 5-pin system.
 - d. Spacers: Furnish cylinder spacers for flush fit with outside face of casework material.
 - e. All locks will provide functionality such that the keyway will remain in the vertical position regardless of installation as a door or drawer.
- C. Lock Locations:
 - 1. Provide locks on ALL tall storage cabinets and wardrobe cabinets, even if not shown on drawings.
 - 2. Provide locks on ALL file drawers.
 - 3. Provide locks on base cabinet doors and drawers as shown on drawings.
 - 4. Provide locks on wall cabinet doors as shown on drawings.
 - 5. Lock Keying:
 - a. Locks shall be capable of being keyed alike, keyed different and/or master keyed as directed by Owner.
 - b. Provide 2 keys per lock and 10 master keys.

2.10 UTILITY SHELVING

- A. Wall-Mounted, Adjustable, Utility Shelving:
 - 1. Shelves:
 - a. Thermally Fused Melamine Laminate (TFM) Panels, 1-inch thick, with 3 mm PVC edgebanding all edges.

01-17-2022

- b. Maximum Length: 36-inches.
 - c. Depth of Shelves: As indicated on drawings.
- 2. Shelf Standards -
 - a. K&V No. 85-ANO-XX; 1.25-inches wide by 1/2-inch deep, double slot design, 1-inch vertical adjustment.
- 3. Shelf Brackets -
 - a. K&V No. 185-ANO-XX; Depth as shown on drawings.
- 4. Shelf Rests:
 - a. K&V No. 106-ANO; or approved equal.

2.11 PLASTIC LAMINATE COUNTERTOPS

- A. Plastic Laminate Countertops: Shall be high-pressure decorative laminate (HPDL) sheet bonded to a core material.
- B. Core Materials:
 - 1. Particleboard: All countertops, unless indicated otherwise: 1-1/8 inch thick ANSI A208.1 M-2 particleboard.
 - a. Exception: Where countertops receive sinks, lavatories, or are subjected to liquids, provide 1-1/8 inch thick Moisture-Resistant MDF (MR-MDF) core.
- C. HPDL Overlay: NEMA LD 3, Grade HGS, 0.048-inch nominal thickness.
- D. Backing Sheet: Provide backing sheet (BKL) under narrow applied drop edge or return. Use of thermoset decorative overlay is not acceptable.
- E. Total Finished Countertop Thickness: 1 1/4-inches.
- F. Performance:
 - 1. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - 2. NSF approved for food contact.
 - 3. Wear Resistance: In addition to specified grade, comply with NEMA LD 3 High Wear Grade requirements for wear resistance.
- G. Exposed Edge Treatment:
 - 1. Square, Self-Edge: Substrate built up to 1 1/4-inches thick; exposed faces covered with edgebanding. Refer to "Edgebanding" Article this Section.
 - a. Application of self-edge: Edge laminated before top.
- H. Back and End Splashes: Same material, same construction.
 - 1. All other Countertops: Back and End Splashes shall be 3/4-inches thick and attached by means of screws from underside of deck through continuous bead of silicone sealant.
 - a. Exposed edges and ends of backsplash shall be covered with edgebanding. Refer to "Edgebanding" Article this Section.
 - 2. Backsplashes in wet areas shall be moisture-resistant MDF (Medex) with high-pressure laminate bonded to all faces, including BKL on the back.
- I. Countertop Accessories:
 - 1. Wall-Mounted Countertop Support Brackets: Provide metal wall bracket, 1/8-inch thick, with black powder coat finish for support of countertops as shown on the Drawings.
 - a. Basis of Design Manufacturer: A&M Hardware (P: 888-647-0200 / Web: www.AandMHardware.com).
 - b. Size: Sized to correspond to countertop depth.
 - c. Provide fire treated solid wood blocking to support and secure brackets when installed at metal stud walls.
 - d. Load capacity shall be 1000 lbs per bracket, minimum.
 - 2. Grommets for Cable Passage through Countertops: 2-1/2 inch OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
 - a. Product: Subject to compliance with requirements, provide "EDP series" by Doug Mockett & Company, Inc., or approved equal.
 - b. Color: Black.

01-17-2022

2.12 PLASTIC LAMINATE MATERIALS

- A. Manufacturer:
 - 1. Specified Manufacturer/s: Formica and Wilsonart.
 - a. Other Acceptable Manufacturer: None identified. No substitutions will be considered or accepted.
- B. Laminate Properties:
 - 1. Laminate Composition: Decorative surface papers impregnated with melamine resins and pressed over kraft paper core sheets impregnated with phenolic resin. Sheets then bonded together under high pressure and high temperatures. Finished sheets trimmed and backs sanded to facilitate bonding to substrate.
 - 2. Surface Burning Characteristics:
 - a. Test Standards: ASTM E 84, ASTM E 162, ASTM E 662, IMO FTP Code Part 2 and Part 5, and UL 723.
 - b. Interior Finish Classification, Fire-Rated Laminate: Class A according to NFPA 101.
 - c. Flame Spread Index: Less than 25; Smoke Developed Index: Less than 450.
 - 3. Surfaces Subject to Food Contact: Comply with NSF Standard 35.
 - 4. Grades: Refer to "Materials" Article this Section.
- C. Plastic Laminate, scheduled on the Drawings as Finish Type PLAM- #.
 - 1. Refer to the "Interior Finish Legend" (Sheet A4.2) for pertinent information on the plastic laminate materials scheduled.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.

3.02 PREPARATION:

- A. Condition casework to average prevailing humidity conditions in installation areas prior to installing.

3.03 INSTALLATION

- A. Separate Cabinet Bases: At the contractor's option, install separate cabinet bases prior to remaining casework as required to coordinate with installation of flooring and base.
- B. Provide and install scribe strips to adjoining walls, accurately fitted, installed with fastenings.
- C. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch of a single plane. Align similar adjoining doors and drawers to a tolerance of 1/16 inch. Bolt adjacent cabinets together with joints flush, tight, and uniform.
- D. Wall Cabinets: Hang wall cabinets straight, level, and plumb. Adjust fronts and bottoms to align in a single plane or straight line. Fasten to hanging strips, masonry, framing, wood blocking, or reinforcements in walls and partitions to provide positive anchorage. Align similar adjoining doors to align in a straight line.
- E. Fasten cabinets to adjacent cabinets and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."
- F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.
- G. Repair or remove and replace defective work as directed on completion of installation.
- H. Adjust casework and hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.04 CLEANING:

- A. Remove and dispose of all packing materials and related construction debris.
- B. Clean cabinets inside and out. Wipe off fingerprints, pencil marks, and surface soil etc., in preparation for final cleaning by the building owner.

3.05 PROTECTION

- A. Protect completed work from damage during remainder of construction period.
- B. DO NOT stand on the installed countertops for any reason.

END OF SECTION 12 32 16

SECTION 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.02 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.05 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Nonmetallic slotted channel systems. Include Product Data for components.
 - 4. Equipment supports.
- C. Welding certificates.

1.06 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 5. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 - 2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 - 3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 - 4. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel and/or Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; MasterSet Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.01 GENERAL

- A. J-hooks shall be used for communication and other low voltage wiring not in conduit.

3.02 INSTALLATION

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

3.03 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway:
 1. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
 2. Space supports for EMT, IMC, and RMC as required by NFPA 70.
 3. Spacing supports for EMT, IMC, and RMC shall be as scheduled in NECA 1, where its Table 1 lists maximum spacing less than stated in NFPA 70
- C. 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:

- a. Two-bolt conduit clamps
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.04 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in 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 shall be weight of supported components plus 200 lb (90 kg).
- 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 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 6. To Steel:
 - a. Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts
 - b. Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
 - c. Spring-tension clamps.
 - 7. To Light Steel: Sheet metal screws.
 - 8. 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.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.05 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.06 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 "Concrete".
- C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.07 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 (0.05 mm).
- B. Comply with requirements in Division 09 "Finishes" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 33 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

- A. This Section includes:
 - 1. Raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.02 DEFINITIONS

- A. Terminology used in this specification is as defined below:
 - 1. EMT: Electrical Metallic Tubing
 - 2. FMC: Flexible Metal Conduit
 - 3. GRS: Galvanized Rigid Steel Conduit
 - 4. IMC: Intermediate Metal Conduit
 - 5. LFMC: Liquidtight Flexible Metal Conduit
 - 6. LFNC: Liquidtight Flexible Nonmetallic Conduit
 - 7. RAC: Rigid Aluminum Conduit
 - 8. RMC: Rigid Metal Conduit
 - 9. RNC: Rigid Nonmetallic Conduit

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Accurately record actual routing of all interior raceways three inches and larger. Indicate dimensions from fixed structural elements.
- C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members in path of conduit groups with supports.
 - 2. HVAC items, plumbing items and architectural features in the paths of conduit groups with common supports.

1.04 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
 - 2. Marked for intended use.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.02 CONDUITS, SURFACE MOUNTED RACEWAYS AND ACCESSORIES

A. Metal Conduit and Tubing

1. Manufacturers:
 - a. AFC Cable Systems, Inc.
 - b. Alfex Corporation, a Southwire Company
 - c. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - d. Electri-Flex Co.
 - e. Indalex
 - f. Manhattan/CDT/Cole-Flex
 - g. O-Z/Gedney; Unit of General Signal (Fittings)
 - h. Republic Raceway
 - i. Tyco International; Allied Tube & Conduit Div.
 - j. Western Tube and Conduit Corporation
 - k. Wheatland Tube Co.
2. RMC:
 - a. GRS: Hot-dip galvanized: ANSI C80.1, UL 6.
 - b. RAC: ANSI C80.5, UL6A.
3. IMC: ANSI C80.6, UL 1242.
4. EMT and Fittings: ANSI C80.3, UL 797.
 - a. Fittings: Set-screw or compression type.
5. FMC: Aluminum or Zinc-coated steel: UL 1.
6. LFMC: Flexible steel raceway with PVC jacket: UL 360.
 - a. Fittings: NEMA FB 1; compatible with raceway and tubing materials.

B. Nonmetallic Raceway

1. Manufacturers:
 - a. AFC Cable Systems, Inc. (Tubing)
 - b. American International.
 - c. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - d. Arnco Corp.
 - e. Cantex Inc.
 - f. Certainteed Corp.; Pipe & Plastics Group.
 - g. Condux International.
 - h. ElecSYS, Inc.
 - i. Electri-Flex Co.
 - j. Lamson & Sessions; Carlon Electrical Products.
 - k. Manhattan/CDT/Cole-Flex.
 - l. Prime Conduit (formerly Carlon)
 - m. RACO; Division of Hubbell, Inc.
 - n. Spiraldut, Inc./AFC Cable Systems, Inc.
 - o. Superflex Ltd.

- p. Thomas & Betts Corporation.
- C. Metal Wireways
 - 1. Manufacturers:
 - a. Cooper B-Line
 - b. EPI-Electrical Enclosures
 - c. Hoffman.
 - d. Square D.
 - 2. Material and Construction: 14 gauge (minimum) sheet steel, sized and shaped as indicated, NEMA 1.
 - 3. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70. Where indicated, provide a barrier to divide wireway into compartments.
 - 4. Finish: Manufacturer's standard phosphate pre-treatment and baked enamel finish.
- D. Surface Metal Raceways
 - 1. Manufacturers:
 - a. Wiremold/Legrand.
 - b. Mono-Systems, Inc.
 - c. Panduit Corp
 - 2. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
 - 3. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.03 BOXES, ENCLOSURES AND CABINETS

- A. General
 - 1. Manufacturers:
 - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - b. Emerson/General Signal; Appleton Electric Company.
 - c. Erickson Electrical Equipment Co.
 - d. Hoffman.
 - e. Hubbell, Inc.
 - f. Killark Electric Manufacturing Co.
 - g. O-Z/Gedney; Unit of General Signal.
 - h. RACO; Division of Hubbell, Inc.
 - i. Robroy Industries, Inc.; Enclosure Division.
 - j. Scott Fetzer Co.; Adalet-PLM Division.
 - k. Spring City Electrical Manufacturing Co.
 - l. Thomas & Betts Corporation.
 - m. Walker Systems, Inc.; Wiremold Company (The).
 - n. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary
- B. Outlet Boxes
 - 1. Sheet Metal Outlet and Device Boxes: NEMA OS 1; UL514A.
 - 2. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

3. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified in the following paragraphs. Manufacturers and model numbers listed are used only to represent the characteristics required and are not intended to restrict the use of other Manufacturers listed above and models that meet the specified criteria.
 - a. Concealed and exposed boxes for lighting:
 - 1) Appleton 40-3/4.
 - 2) RACO 160 series.
 - 3) Steel City 54170 series.
 - b. Boxes for flush switches, receptacles, or other general devices:
 - 1) Appleton 4SVB series; 8400 series cover.
 - 2) RACO 198 series; 770 series cover.
 - 3) Steel City CWV series; 52-C-00 series cover.
 - c. Boxes for flush switches, receptacles, or other general devices installed in masonry construction:
 - 1) Appleton MI-250 series or MI-350 series.
 - 2) RACO 690 series or 960 series.
 - 3) Steel City GW series.
 - d. Boxes for telephone, data, telecommunications and audio-video outlets, refer to:
 - 1) Division 26 Section "Common Work Results for Communications"
- C. Junction and Pull Boxes
 1. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
 2. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast iron or aluminum with gasketed cover.

2.04 FACTORY FINISHES

- A. Finish: For metal wireway and surface raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled metal wireway and surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General
 1. Install in accordance with manufacturer's instructions
- B. RACEWAYS
 1. General
 - a. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this article are stricter.
 - b. Provide sizes and types of raceways as indicated on the Drawings. Sizes are based on THWN insulated copper conductors, except where noted otherwise. Where sizes are not shown on the Drawings or in the Specifications, size raceways in accordance with NFPA 70 requirements for the number, size and type of conductors installed. Minimum raceway size: 1/2 inch (concealed and exposed); 1 inch (underground and under slab).
 - 1) 1/2 inch conduit shall contain maximum (5) #12AWG conductors or (3) #10AWG conductors.
 - 2) 3/8 inch flexible conduit may be used for light fixture whips.

- c. Provide all raceways, fittings, supports, and miscellaneous hardware required for a complete electrical system as described by the Drawings and Specifications.
- d. Install a green-insulated, equipment-grounding conductor, which is bonded to the electrical system ground, in all raceways, with the exception of Service Entrance raceways.
- e. Install grounding bushings on all conduit terminations and bond to the enclosure, equipment grounding conductor, and electrical system ground.
- f. Install raceways concealed in walls or above suspended ceilings in finished areas. When approved by the Contract Administrator, raceways may be installed concealed in elevated floor slabs. Do not install raceways horizontally within slabs on grade.
- g. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- h. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- i. Make bends and offsets so inside diameters are not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- j. Install raceways:
 - 1) To meet the requirements of the structure and the requirements of all other Work on the Project.
 - 2) To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.
 - 3) Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Contract Administrator.
 - 4) Parallel or perpendicular to building lines or column lines.
 - 5) When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- k. Support raceways from structural elements of the building as required by NFPA 70, Division 26 Section "Hangers and Supports for Electrical Systems". Do not support raceways by hangers used for any other systems foreign to the electrical systems; and, do not attach to other foreign systems. Do not lay raceways on top of the ceiling system.
- l. Provide support spacing in accordance with NFPA 70 requirements, and at a minimum in accordance with NEMA standards. Support by the following methods:
 - 1) Attach single raceway directly to structural steel with beam clamps.
 - 2) Attach single raceway directly to concrete with one-hole clamps or clips and anchors. Outdoors and wherever subject to dampness or moisture, offset raceways from the surface by using galvanized clamps and clamp backs, to mitigate moisture entrapment between raceways and surfaces.
 - 3) Attach groups of raceway to structural steel with slotted support system attached with beam clamps. Attach raceway to slotted channel with approved raceway clamps.
 - 4) Attach groups of raceway to concrete with cast-in-place steel slotted channel fabricated specifically for concrete embedment. Attach raceway to steel slotted channel with approved raceway clamps.
 - 5) Hang plumb horizontally suspended single raceway using a threaded rod. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to threaded rod with approved raceway clamps.

- 6) Hang horizontally suspended groups of raceway using steel slotted support system suspended from threaded rods. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to steel slotted channel with approved raceway clamps.
 - 7) Support conductors in vertical raceway in accordance with NFPA 70 requirements.
 - 8) Cross-brace suspended raceway to prevent lateral movement during seismic activity.
 - 9) Use pre-fabricated non-metallic spacers for parallel runs of underground or under-slab conduits, either direct buried or encased in concrete.
 - m. Install electrically- and physically-continuous raceways between connections to outlets, boxes, panelboards, cabinets, and other electrical equipment with a minimum possible number of bends and not more than the equivalent of four 90-degree bends between boxes. Make bends smooth and even, without flattening raceway or flaking the finish.
 - n. Protect all electrical Work against damage during construction. Repair all Work damaged or moved out of line after rough-in, to meet the Contract Administrator's approval, without additional cost to the Owner. Cover or temporarily plug openings in boxes or raceways to keep raceways clean during construction. Clean all raceways prior to pulling conductors or cables.
 - o. Align and install raceway terminations true and plumb.
 - p. Complete raceway installation before starting conductor installation.
 - q. Install a pull cord in each empty raceway that is left empty for installation of wires or cables by other trades or under separate contracts. 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 cord.
 - r. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints.
 - s. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces or from building exterior to building interior.
 - 2) Where otherwise required by NFPA 70.
 - t. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment as required by other requirements of the construction documents. FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
2. RMC
- a. Use GRS or IMC in the following areas:
 - 1) Where indicated.
 - 2) For Emergency Feeders.
 - 3) All raceways penetrating slabs on grade (use plastic-coated raceway or provide with a corrosion resistant approved mastic coating). This shall include the 90-degree elbow below grade and the entire vertical transition to above grade.
 - b. Use RAC in the following areas:
 - 1) Indoors above grade.

- 2) Interior wet or damp locations.
 - c. Do not use RAC:
 - 1) Below grade.
 - 2) Imbedded in concrete or other areas corrosive to RAC.
 - 3. EMT
 - a. Use EMT in the following areas:
 - 1) Where indicated.
 - 2) Interior concealed locations for:
 - a) Branch circuits.
 - b) Feeders.
 - c) Emergency branch circuits.
 - d) Low-voltage control, security, and fire alarm circuits
 - 3) Exposed where not subject to physical damage
 - a) Mechanical rooms
 - b. Do not use EMT:
 - 1) Below grade.
 - 2) In exterior applications when exposed.
 - 4. FMC and LFMC
 - a. Use FMC or LFMC:
 - 1) For the final 24 inches of raceway to all motors, transformers, and other equipment subject to vibration or movement.
 - 2) From outlet boxes (attached to building structure) to recessed light fixtures. Install sufficient length to allow for relocating each light fixture within a 5-foot radius of its installed location.
 - 3) Use FMC only in dry locations
 - b. Do not use FMC or LFMC:
 - 1) For branch circuits, homeruns or feeders.
 - 2) In lengths exceeding 6 feet.
 - 5. Telephone and Signal/Data System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
- C. RACEWAY FITTINGS:
- 1. Compatible with raceways and suitable for use and location.
 - 2. RMC and IMC: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 - 3. Join raceways with fittings designed and approved for that purpose and make joints tight.
 - 4. Use insulating bushings to protect conductors at raceway terminations:
 - a. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 - b. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- D. Smoke Evacuation

1. Life Safety feeders shall be installed in fire rated enclosures or shall be constructed as a rated assembly per NEC700 and IBC 403.
2. Life Safety feeders shall not be routed in the same enclosures as other feeder types except as permitted by NEC 700.
3. Life Safety loads shall be as defined by NEC 700 and IBC 403 including but not limited to the following:
 - a. Egress Lighting

E. BOXES

1. General
 - a. Verify locations of device boxes prior to rough in.
 - b. Set boxes at elevations to accommodate mounting heights as specified or indicated on the Drawings.
 - c. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Adjust box locations to accommodate intended purpose.
 - d. Install boxes to preserve fire ratings of walls, floors, and ceilings.
 - e. Install flush wall-mounted boxes without damaging wall insulation or reducing its effectiveness.
 - f. Support boxes independently of raceway.
 - g. Clean the interior of boxes to remove dust, debris, and other material. Clean exposed surfaces and restore finish.
 - h. Adjust flush-mounted boxes to make front edges flush with finished wall material.
 - i. Provide boxes of the depth required for the service, device and the application, and with raised covers set flush with the finished wall surface for boxes concealed in plaster finishes. Select covers with the proper openings for the devices being installed in the boxes. Install boxes flush unless otherwise indicated.
 - j. Install outlet boxes in firewalls complying with UL requirements, with box surface area not exceeding 16 square inches; and, when installed on opposite sides of the wall, separate by a distance of at least 24 inches.
2. NEMA Enclosure ratings:
 - a. NEMA 250, type 1
 - 1) Provide at interior and dry locations
3. Outlet Boxes
 - a. Install all electrical devices, such as plug receptacles, lamp receptacles, light switches, and light fixtures in or on outlet boxes.
 - b. Locations of outlets on Drawings are approximate; and, except where dimensions are shown, determine exact dimensions for locations of outlets from plans, details, sections, or elevations on Drawings, or as directed by Contract Administrator. Locate outlets generally from column centers and finish wall lines or to centers or joints of wall or ceiling panels.
 - c. Locate outlet boxes so they are not placed back-to-back in the same wall, and in metal stud walls, so they are separated by at least one stud space, to limit sound transmission from room to room. Install outlet boxes in accessible locations and do not install outlets above ducts or behind furring.
 - d. Install extension and plaster rings as required by NFPA 70.
 - e. Carefully set outlet boxes concealed in non-plastered block walls so as to line up with wall joints. Coordinate the box and raceway installation with the wall construction as required for a flush and neat appearing installation. Outlet box extensions may be used where necessary.
 - f. Do not exceed allowable fill per NFPA 70.

- g. Where multiple devices are shown grouped together, gang mount with a common cover plate.
- 4. Junction and Pull Boxes
 - a. Install junction and pull boxes above accessible ceilings and in unfinished areas.
 - b. Provide boxes set flush in painted walls or ceilings with primer coated cover.
 - c. Where junction and pull boxes are installed above an inaccessible ceiling, locate so as to be easily accessible from a ceiling access panel.

3.02 IDENTIFICATION

- A. Refer to Division 26 Section "Identification for Electrical Systems" for identification materials.
- B. Raceway Identification
 - 1. Conduit and raceways are to be color coded for ease of identification. Where a facility standard already exists, that shall be followed. Where no standard exists for color-coding, provide in accordance with table below.
 - a. Conduit shall be color-coded from the factory. Junction boxes, fittings, and connectors are not required to be painted to match.
 - b. As an alternative, submit deduct to omit use of factory-painted conduit. Tape or paint are to be used to identify conduits and junction boxes and/or fittings are to be painted in accordance with facility standard or color table.

Conduit Service	Color Description
Building Automation and Controls	Blue
Fire Alarm	Red
Life Safety Power Branch	Yellow
Critical Power Branch	Orange
Equipment Branch	Green
Emergency Power Distribution Not Listed Above	Purple

- 2. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size. Use the following means of identification:
 - a. Self-Adhesive Vinyl Labels
 - b. Snap-Around Labels
 - c. Snap-Around, Color-Coding Bands
 - d. Self-Adhesive Vinyl Tape
 - 3. Color for Printed Legend:
 - a. Power Circuits: Black letters on an orange field.
 - b. Legend: Indicate system or service and voltage, if applicable
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identification device shall be:
 - 1. Self-adhesive vinyl label
 - 2. Snap around label
 - 3. Self-adhesive vinyl tape applied in bands.
- D. Accessible Raceways of Auxiliary Systems: Identify the following systems using the same identification device as other accessible raceways 600V or less, and with the indicated color scheme for each system:
 - 1. Fire Alarm System: Red.
 - 2. Fire-Suppression Supervisory and Control System: Red and yellow.
 - 3. Combined Fire Alarm and Security System: Red and blue.
 - 4. Security System: Blue and yellow.
 - 5. Mechanical and Electrical Supervisory System: Green and blue.

6. Telecommunication System: Green and yellow.
7. Control Wiring: Green and red.
- E. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
- F. Junction Boxes and pull boxes
 1. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.
 2. The junction box where a homerun ends and the circuit is distributed shall be marked. Junction boxes shall be marked approximately every 100 feet along homerun path to panel.

END OF SECTION 26 05 33

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes:
 - 1. Raceways, fittings, boxes for underground electrical systems
 - 2. Pull boxes
 - 3. Direct buried electrical ducts
 - 4. Concrete-encased electrical ducts

1.02 DEFINITIONS

- A. Terminology used in this specification is as defined below:
 - 1. GRS: Galvanized Rigid Steel Conduit
 - 2. RMC: Rigid Metal Conduit
 - 3. RNC: Rigid Nonmetallic Conduit

1.03 COORDINATION

- A. Coordinate layout and installation of ducts, handholes, and pull boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into handholes and pull boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain from handholes, and as approved by the Contract Administrator.

1.04 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Product data for the following products:
 - a. Raceways, Raceway fittings, pull boxes, and warning tape.
- B. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Accurately record actual routing of all exterior buried raceway including coordination with other surrounding utilities and underground structures. Provide scaled plans and sections that indicate dimensions from finished grade or other fixed structural elements.

1.05 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
 - 2. Marked for intended use.
- C. Comply with NFPA 70 and ANSI C2.
- D. Test and inspect pre-cast concrete utility structures according to ASTM C 1037.
- E. Non-concrete Handhold and Pull-Box Prototype Test: Test prototypes of pull boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed.
- C. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.02 RACEWAYS AND FITTINGS

- A. Metal Conduit and Tubing
 1. Manufacturers:
 - a. AFC Cable Systems, Inc.
 - b. Alfex Corporation, a Southwire Company
 - c. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - d. Electri-Flex Co.
 - e. Indalex
 - f. Manhattan/CDT/Cole-Flex
 - g. O-Z/Gedney; Unit of General Signal (Fittings)
 - h. Republic Raceway
 - i. Tyco International; Allied Tube & Conduit Div.
 - j. Wheatland Tube Co.
 2. RMC:
 - a. GRS: Hot-dip galvanized: ANSI C80.1, UL 6
- B. Nonmetallic Raceway and Tubing
 1. Manufacturers:
 - a. AFC Cable Systems, Inc. (Tubing)
 - b. American International.
 - c. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - d. Arnco Corp.
 - e. Cantex Inc.
 - f. Certainteed Corp.; Pipe & Plastics Group.
 - g. Condux International.
 - h. ElecSYS, Inc.
 - i. Electri-Flex Co.
 - j. Lamson & Sessions; Carlon Electrical Products.
 - k. Manhattan/CDT/Cole-Flex.
 - l. RACO; Division of Hubbell, Inc.
 - m. Spiralduct, Inc./AFC Cable Systems, Inc.

- n. Superflex Ltd.
 - o. Thomas & Betts Corporation.
2. RNC: Schedule 40 (type EPC-40-PVC) PVC: NEMA TC 2, UL 651.
- a. Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.
- C. DUCT ACCESSORIES
- 1. Duct Separators shall be factory-fabricated rigid interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 - 2. Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
 - 3. Concrete warning planks shall be nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.
 - a. Color: Red dye added to concrete during batching.
 - b. Labeling: Mark each plank with "ELECTRICAL" in 2-inch high, 3/8-inch deep letters.
- D. Materials: Comply with ASTM C858 and with Division 03 Section "Cast-In-Place Concrete."

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Receive and inspect precast or premanufactured equipment.
- B. Examine components before installation. Reject components that are damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install all components per manufacturer's recommendations.

3.03 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Feeders 600volts and Less: RNC, NEMA Type EPC-40 PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 volts and Less: RNC, NEMA Type EPC-40 PVC, in direct-buried duct bank, unless otherwise indicated.
- C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40 PVC, direct-buried duct bank, unless otherwise indicated.
- D. Underground Ducts Crossing Paved Paths: RNC, NEMA Type EPC-40 PVC, encased in reinforced concrete.

3.04 EARTHWORK

- A. Excavation and Backfilling: Comply with Division 31 Section "Earth Moving" but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling and compaction is complete.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants"
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.05 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down away from buildings and equipment. Slope ducts from a high point in runs between two points to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48-inches, both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- D. Building Wall Penetrations: Make a transition from underground duct to PVC coated rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."
- E. Sealing: Provide temporary closure at termination of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- F. Pulling Cord: Install 100-lbf test nylon cord in ducts, including spares.
- G. Concrete-Encased Ducts: Support ducts on duct separators.
 - 1. Separator installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and ducts to prevent floating during concreting. Stagger separators approximately 6-inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around the ducts or duct group.
 - 2. Concreting Sequence: Pour each run of envelope between handholes, pull boxes or other terminations in one continuous operation.
 - a. Start at one end finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to the manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install ¾-inch reinforcing rod dowels 18-inches into concrete on both sides of joint near corners of envelope.
 - 3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct bank application.
 - 4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 - 5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 - 6. Minimum Space between Ducts: 3-inches between ducts and exterior envelope wall, 2-inches between ducts for like services, and 4-inches between power and signal ducts.
 - 7. Depth: Install top of duct bank at least 24-inches below finished grade in areas not subject to deliberate traffic, and at least 30-inches below finished grade in deliberate traffic paths of vehicles, unless otherwise indicated.

8. Stub-Ups: Use manufactured PVC coated rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3-inches of concrete.
 - b. Stub-ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60-inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 9. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3-inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18-inches. Space additional tapes 12-inches apart, horizontally.
- H. Direct-Buried Duct Banks:
1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6-inches between tiers.
 3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6-inches in nominal diameter.
 4. Install backfill as specified in Division 31 Section "Earth Moving."
 5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4-inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
 6. Install ducts with a minimum of 3-inches between ducts for like services and 6-inches between power and signal ducts.
 7. Depth: Install top of duct bank at least 36-inches below finished grade, unless otherwise indicated.
 8. Set elevation of bottom of duct bank below the frost line.
 9. Install manufactured PVC coated rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3-inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60-inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 10. Warning Planks: Bury warning planks approximately 12 inches above all direct-buried ducts and duct banks placing them 24-inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18-inches. Space additional planks 12-inches apart, horizontally.

3.06 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.07 INSTALLATION ACCEPTANCE

- A. Prior to final acceptance of the duct bank and associated structures, pull an aluminum or wood test mandrel through the duct to prove joint integrity and to verify ducts have not been deformed. Provide mandrel equal to 80 percent fill of the duct.
- B. Test duct bank, handhole and pull box grounding to ensure electrical continuity of grounding and bonding connections.
- C. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems." Correct any deficiencies and retest as specified above.
- D. Clean internal surfaces of handholes and pull boxes and remove foreign materials.

END OF SECTION 26 05 43

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes the following:
 - 1. Nameplates
 - 2. Identification for raceways and metal-clad cable.
 - 3. Identification for conductors, communication, and control cable.
 - 4. Labels for junction boxes and pull boxes.
 - 5. Labels for wiring devices.
 - 6. Underground-line warning tape.
 - 7. Warning labels and signs.
 - 8. Instruction signs.
 - 9. Equipment identification labels.
 - 10. Miscellaneous identification products.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Where a facility identification standard already exists, that standard shall be continued. Where an identification standard does not exist, color-coding and identification shall be as described herein.
- B. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- C. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- D. Coordinate installation of identifying devices with location of access panels and doors.
- E. Install identifying devices before installing acoustical ceilings and similar concealment.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7 and that are acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.
- B. Comply with ANSI A13.1 and ANSI C2.
- C. Comply with NFPA 70.
- D. Comply with 29 CFR 1910.145.

PART 2 - PRODUCTS AND MATERIALS

2.01 GENERAL

- A. Location, text, and method of identification to be used is noted in individual sections. Refer to related sections for additional identification requirements.

2.02 NAMEPLATES

- A. Engraved, Laminated Acrylic or Melamine Label, adhesive backed. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high

label; where 2 lines of text are required, use labels 2 inches (50 mm) high. For elevated Components, increase sizes of labels and letters to those appropriate for viewing from the floor. Confirm nameplate colors with building standards.

1. Normal systems - white letters on a black background.
2. Emergency systems - white letters on a red background

2.03 LABELS FOR RACEWAYS AND METAL-CLAD CABLE

- A. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- C. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.04 LABELS FOR JUNCTION BOXES AND PULL BOXES

- A. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.

2.05 LABELS FOR WIRING DEVICES AND LIGHTING CONTROL DEVICES

- A. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.
- B. Engraved, Laminated Acrylic or Melamine Label: adhesive backed. Minimum letter height shall be 3/16 inch (4.76 mm).
 1. Normal systems - white letters on a black background.
 2. Emergency systems - white letters on a red background
- C. Engraved cover plates: Provide with white letters. White or ivory cover plates shall have black letters.

2.06 MARKERS FOR CONDUCTOR AND CONTROL CABLES

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.
- D. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- (0.35-mm-) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
- E. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.

2.07 TAGS

- A. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.08 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1. Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend shall indicate type of underground line.

2.09 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145. Attachment method shall be acceptable to the manufacturers of the equipment to which the nameplates are being applied and shall not compromise any NRTL listing or labeling criteria.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).
- E. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning (208 Volts): "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
 - 3. Workspace Clearance Warning (480 Volts): "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 48 INCHES (915 MM)."

2.10 ARC FLASH WARNING LABELS

- A. 3.5 in. x 5 in., unless otherwise noted by Owner, thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. All labels will be based on recommended overcurrent device settings and will be printed after the results of the analysis have been presented and after any system changes, upgrades, or modifications have been incorporated in the system.
- C. The label shall include the following information, at a minimum:
 - 1. Location designation
 - 2. Nominal voltage
 - 3. Available Fault Current
 - 4. Flash protection boundary
 - 5. Hazard risk category
 - 6. Incident energy
 - 7. Working distance
 - 8. Engineering report number, revision number and issue date.
- D. Labels shall be machine printed, with no field markings.

2.11 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes. Unless indicated otherwise, provide with minimum 3/8-inch- (10-mm-) high letters.
 - 1. Punched or drilled for mechanical fasteners.
 - 2. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
 - 3. Normal systems: Engraved legend with white letters on black face.
 - 4. Essential Systems: Engraved legend with white letters on red face.

2.12 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength: 50 lb (22.6 kg), minimum.
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: Black, except where used for color-coding.

2.13 PAINTED IDENTIFICATION

- A. Paint materials and application requirements are specified in Division 09 painting Sections.
 - 1. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):
 - a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior concrete and masonry primer.
 - 2) Finish Coats: Interior semi-gloss alkyd enamel.
 - 2. Interior Concrete Unit Masonry:
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
 - 1) Block Filler: Concrete unit masonry block filler.
 - 2) Finish Coats: Interior semi-gloss acrylic enamel.
 - 3. Interior Gypsum Board:
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior gypsum board primer.
 - 2) Finish Coats: Interior semi-gloss acrylic enamel.
 - 4. Interior Ferrous Metal:
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior ferrous-metal primer.
 - 2) Finish Coats: Interior semi-gloss acrylic enamel.
 - 5. Interior Zinc-Coated Metal (except Raceways):
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior zinc-coated metal primer.
 - 2) Finish Coats: Interior semi-gloss acrylic enamel.

2.14 FASTENERS FOR NAMEPLATES, LABELS AND SIGNS

- A. Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat lock washers unless otherwise noted.

PART 3 - EXECUTION

3.01 PREPERATION

- A. Verify identity of each item before installing identification products.

- B. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- C. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. For surfaces that require finish work, apply identification devices after completing finish work.
- C. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- D. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- E. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
- F. Equipment Nameplates and Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual

END OF SECTION 26 05 53

SECTION 26 05 73 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies, and the setting of these devices.
 - 1. Also include coordination of series-rated devices where series rating is specified in other sections and where indicated on Drawings.
 - 2. The AIC ratings indicated on the Drawings are preliminary and will be finalized based on the results of the fault current study. Device ratings for furnished equipment shall be as required by the results of the fault current study at no additional cost.
- B. Study must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If study has not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project.

1.02 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-study specialist.
- D. Studies:
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Coordination-study report.
 - 3. Equipment evaluation report.
 - 4. Arc-Flash Hazard Analysis.
 - 5. Setting report.
- E. Preliminary Studies
 - 1. Submit a Fault-Current Study and Overcurrent Protective Device Setting Study to the Engineer prior to receiving final approval of the shop drawings and/or prior to release of equipment drawings for manufacturing. The preliminary studies shall provide sufficient data to ensure that the selection of equipment will have adequate ratings and the protective device trip characteristics will be satisfactory.
- F. Final Studies
 - 1. Perform a final Fault-Current Study, Overcurrent Protective Device Setting Study and Arc Flash Hazard Analysis at the end of the construction cycle when circuits are installed and all equipment is on site and/or installed such that complete and accurate data may be obtained.
- G. Submittals for construction
 - 1. The single-line diagram and results of the final short-circuit, protective device coordination, and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound volumes of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) volumes of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies of the short-circuit input and output data shall be provided on CD in PDF format.

2. Provide the single-line diagram, short-circuit, coordination, and arc flash project files to the Owner in electronic format including all project files, libraries, etc. to allow the owner to update and to print additional copies, labels, etc.
3. A copy of the computer analysis software viewer program is required to accompany the electronic project files, to allow the Owner to review all aspects of the project and print arc flash labels, one line diagrams, etc.
4. The report shall include the following sections:
 - a. Executive Summary,
 - b. Descriptions, purpose, basis and scope of the study.
 - c. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short circuit duties.
 - d. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, and fuse selection.
 - e. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
 - f. Details of the incident energy and flash protection boundary calculations.
 - g. Recommendations for system improvements, where needed.
 - h. One line diagram.
 - i. Equipment specific arc flash labels.
- H. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
 1. Accurately record on the One-Line Diagram actual ratings and settings for all overcurrent devices, both adjustable and non-adjustable, including all changes made during construction, due to the study, or both.
- I. Electronic files, in an SKM-compatible format, of the time-current characteristic curves for every different overcurrent device used in the reports.

1.03 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 399 for general study procedures.
- D. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- E. Comply with IEEE 1584 and NFPA 70E for arc-flash hazard calculations.

PART 2 - PRODUCTS AND MATERIALS

2.01 COMPUTER SOFTWARE DEVELOPERS

- A. Computer Software Developers: Subject to compliance with requirements, provide computer software programs developed by one of the following:
 1. CYME International, Inc.
 2. EDSA Micro Corporation.
 3. Electrical Systems Analysis, Inc.

4. SKM Systems Analysis, Inc.
5. Operation Technology, Inc.

2.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.
 1. Simultaneous faults.

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. Devices to be coordinated are indicated on Drawings.
- B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.
- C. Fault current study and coordination study to be performed prior to the final submittals for any piece of electrical equipment which has an AIC rating or an over-current protective device so that correct equipment gets ordered for the project conditions.
- D. Arc Flash Study must be performed after conductors and equipment have been installed and after the project's utility company confirms the available fault current. A final coordination study with all device settings shall be submitted with the Arc Flash Study. The goal of the revised settings is to minimize the arc flash hazard while maintaining reasonable coordination and selectivity. For the components of emergency and legally required standby system components, full selectivity must be maintained.

3.02 SYSTEM COMPONENTS TO BE INCLUDED IN STUDIES

- A. Study shall begin with the utility and each alternate power source overcurrent device(s) serving the Project and end at the last branch circuit overcurrent protective device. This includes studies of the complete paths on both sides of any transfer switch, contactor or circuit breaker.
- B. Components include, but are not limited to:
 1. Switchgear
 2. Switchboards
 3. Distribution Panelboards
 4. Panelboards
 5. Generators

3.03 POWER SYSTEM DATA FOR STUDIES

- A. Gather and tabulate the following input data to support studies:
 1. Product Data for overcurrent protective devices specified in other Division 26 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. Impedance of utility service entrance.
 3. Electrical distribution system diagram showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.

- b. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
- c. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.
- d. Busway ampacity and impedance.
- 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Magnetic inrush current overload capabilities of transformers.
 - c. Ratings, types, and settings of utility company's overcurrent protective devices.
 - d. Time-current-characteristic curves of devices indicated to be coordinated.
 - e. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - f. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - g. Panelboards, switchboards, and interrupting ratings in amperes rms symmetrical.

3.04 FAULT-CURRENT STUDY

- A. Source Impedance:
 - 1. Utility company's fault-current contribution as indicated.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard. Estimated conductor lengths, typical generator, transformer, motor, and utility data may be used for the preliminary study.
- E. Actual installed conductor lengths, test and/or nameplate data for all generators, transformers, motors 50 HP and larger, capacitors, reactors, or other equipment that may affect the study shall be used for the final study.
- F. Comply with IEEE 242 recommendations for fault currents and time intervals.
- G. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:
 - 1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.
 - 2. Low-Voltage Fuses: IEEE C37.46.
 - 3. Circuit Breakers: IEEE C37.13.
- H. Study Report:
 - 1. Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report.
 - 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
 - 3. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults.

- I. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties.

3.05 COORDINATION STUDY

- A. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.
- B. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.
- C. Comply with IEEE 242 recommendations for fault currents and time intervals.
- D. Transformer Primary Overcurrent Protective Devices:
 1. Device shall 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 shall protect transformer according to IEEE C57.12.00, for fault currents.
- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.
- F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve the level of selective coordination required in the contract documents or by the edition of the National Electrical Code (including any local jurisdiction amendments) the project must comply with. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information where applicable:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Maximum fault-current cutoff point.
 - g. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - h. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.
 - i. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves. The frequent fault portion of the damage curve should not be shown unless the transformer feeds overhead lines. The shifted curve for line-to-ground faults on the secondary side shall be shown on the ground fault plot.

- j. Ground fault protective devices shall be shown on separate TCC plots. The first phase overcurrent relay and any negative sequence relays on the primary side of a delta-wye transformer shall be shown.
- 3. Completed data sheets for setting of overcurrent protective devices.
- 4. For emergency, legally required standby and health care essential power systems, such systems must selectively coordinate to the values indicated below unless local amendments to the National Electrical Code require a different value.
 - a. Health Care Essential Electrical Systems (NEC article 517)
 - 1) Equipment Branch 0.10 seconds
 - 2) Critical Branch 0.01 seconds
 - 3) Life-Safety Branch 0.01 seconds

3.06 OVERCURRENT PROTECTIVE DEVICE SETTING

- A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of overcurrent protective devices within equipment.
 - 1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:
 - a. Verify that overcurrent protective devices meet parameters used in studies.
 - b. Adjust devices to values listed in study results.
 - c. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 100.7 and 100.8 in NETA ATS.

3.07 ARC-FLASH HAZARD ANALYSIS

- A. Determine arc-flash incident energy levels and flash protection boundary distances based on the results of the Short-Circuit and Coordination studies. Perform the analysis under worst-case arc-flash conditions for all modes of operation.
- B. Identify all locations and equipment to be included in the arc-flash hazard analysis:
 - 1. Include a copy of the facility one-line in the report.
 - 2. Identify the possible system operating modes including tie-breaker positions, and parallel generation.
 - 3. Calculate the arcing fault current flowing through each branch for each fault location.
 - 4. Determine the time required to clear the arcing fault current using the protective device settings and associated trip curves.
 - 5. Select the working distances based on system voltage and equipment class.
 - 6. Calculate the incident energy at each fault location at the prescribed working distance.
 - 7. Determine the hazard/risk category (HRC) for the estimated incident energy.
 - 8. Calculate the flash protection boundary at each fault location.
 - 9. Document the assessment in reports and one-line diagrams.
 - 10. Provide labels to be placed on each piece of equipment analyzed. Label shall show the calculated incident energy and hazard/risk category for the calculated incident energy.
- C. Results of the arc-flash study shall be summarized in a final report containing the following:
 - 1. Basis, method of hazard assessment, description, purpose, scope, and date of the study.
 - 2. Tabulations of the data used to model the system components and a corresponding one-line diagram.
 - 3. Descriptions of the scenarios evaluated and identification of the scenario used to evaluate equipment ratings.

4. Tabulations of equipment incident energies, hazard risk categories, and flash protection boundaries. The tabulation shall identify and clearly note equipment that exceeds allowable incident energy ratings.
 5. Conclusions and recommendations.
- D. Arc Flash Warning Labels
1. Provide required arc-flash labeling and placement of labels as described in Division 26 Section "Identification for Electrical Systems".
 2. Arc flash labels shall be provided on all serviceable equipment in accordance with NFPA 70E.
- E. Arc Flash Training
1. Provide training for the Owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours).

END OF SECTION 26 05 73

SECTION 26 09 23 LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes the following lighting control devices:
 - 1. Indoor occupancy sensors.
 - 2. Switchbox mounted occupancy sensors.

1.02 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Occupancy sensors
 - a. Catalog cut sheets, including major and minor motion coverage patterns, time delay and sensitivity adjustability settings, load restrictions when used with electronic ballasts and performance specification items indicating compliance with this specification.
 - b. Documentation showing compliance with California Energy Commission certification.
- B. Shop Drawings:
 - 1. Light-level sensors
 - a. Show installation details.
 - b. Interconnection diagrams showing field-installed wiring.
 - 2. Occupancy sensors
 - a. Show installation details.
 - b. Lighting plan showing location, mounting height, orientation and coverage area of each sensor and coordination with other trades.
 - c. Interconnection diagrams showing field-installed wiring.
 - d. Include diagrams for power, signal, and control wiring.
 - e. List of ballast types and lamp combinations compatible with occupancy sensors.
 - f. For any manufacturer submitted other than that listed as the Basis of Design, provide the following information for Engineer review:
 - 1) Factory-generated occupancy sensor layout on project lighting plans with sensor location, orientation and product type clearly marked on plans. Sensor placement shall be coordinated with project reflected ceiling plan layout, ceiling heights, lights, diffusers, and any other ceiling devices and equipment.
 - 2) List of any deviations to this specification or Basis of Design products.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
 - 1. Occupancy sensors

- a. Manufacturer's installation instructions, including instructions for storage, handling, protection, examination, preparation, start-up calibration and installation.
- b. Product data clearly showing sensor field adjustments, including dip switch setting definitions and location of settings within sensors.
- c. Manufacturer's maintenance, including operating and adjustment instructions.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Occupancy Sensors
 1. Products supplied shall be from a single manufacturer that has been continuously involved in the manufacturing of occupancy sensors for a minimum of 5 years.
 2. Products shall be manufactured by an ISO 9001 certified manufacturing facility.
 3. Manufacturer shall test all equipment prior to shipment.

1.06 WARRANTY

- A. Occupancy manufacturers shall provide a five (5) year warranty for sensors and accessories from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 INDOOR OCCUPANCY SENSORS

- A. In the Lighting Control Device Schedule, where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 1. Basis-of-Design Product: The specified occupancy sensor is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the schedule.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors. Integral relay unit for line voltage sensors and a separate relay unit for low voltage sensors.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Unless otherwise indicated, turn lights and motor or equipment loads on when covered area is occupied, and turn loads off when unoccupied; with a time delay for turning loads off, adjustable over a minimum range of 1 to 15 minutes with a maximum of 30 minutes.
 3. Low Voltage Occupancy Sensors
 - a. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the power pack.
 - b. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 20-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70; different dc voltages and mA ratings may be acceptable as defined by NFPA 70 and when coordinated and compatible with connected occupancy sensors.
 - c. Sensors shall be capable of being combined with additional sensors to achieve adequate coverage.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.

- b. Power Pack: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
- 5. Indicator: LED, to show when motion is detected during testing and normal operation of the sensor.
- 6. Bypass Switch: Override the "on" function in case of sensor failure, concealed on unit to prevent tampering.
- 7. Sensor coverage pattern shall have been confirmed with Nema WD7 Guide and Robotic test method.
- 8. UL Listed for dry locations and complies with local codes.
- 9. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.
- 10. Field selectable time delay and sensitivity settings or the capability for self-adjusting technologies to optimize time delay and sensitivity settings to respond to occupancy usage patterns. Occupancy usage patterns shall be saved in a non-volatile memory that retains settings in the event of a power outage.
- 11. Sensors shall be capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.
- 12. Isolated relay with NO and NC contacts to interface with BMS, HVAC and or other building monitoring systems.
- 13. Sensors and related relays shall be compatible with the specific lighting types controlled.
- 14. Finish: Available in white or off-white finish.
- C. PIR Type: Ceiling or wall mounted as indicated on plans; detect occupancy by sensing a combination of infrared heat and movement.
 - 1. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
 - 2. Detection Coverage: As indicated in Lighting Control Device Schedule on Drawings.
 - 3. Sensor shall utilize pulse count processing and digital signature analysis to respond only to those signals caused by human motion.
 - 4. Sensor shall provide high immunity to false triggering from RFI and EMI.
 - 5. Sensor shall have a multiple-segmented fresnel lens in a multiple-tier configuration, with grooves to eliminate dust and residue buildup. Sensor shall be capable of accepting mask inserts to mask specific portions of the lens to prevent false triggering.
- D. Ultrasonic Type: Ceiling mounted as indicated on plans; detect occupancy by sensing a change in pattern of reflected ultrasonic energy.
 - 1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 - 2. Detection Frequency (Small Area – 500 sq ft and less): Ultrasonic operating frequency shall be crystal controlled at 40 kHz within +/- 0.005% tolerance to assure reliable performance and eliminate sensor cross-talk.
 - 3. Detection Frequency (Medium and Large Areas – greater than 500 sq ft): Ultrasonic operating frequency shall be crystal controlled at 32 kHz within +/- 0.005% tolerance, to assure reliable performance and eliminate sensor cross-talk.
 - 4. Sensors shall be capable of automatically adapting to airflow conditions or filtering frequency spectrum related to air movement.
 - 5. Detection Coverage: As indicated in Lighting Control Device Schedule on Drawings.
- E. Dual-Technology Type: Ceiling or wall mounted as indicated on plans; detect occupancy by using a combination of PIR and ultrasonic detection methods. Particular technology or

combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: PIR Component detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and Ultrasonic component detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Different LED indicator colors for each sensing technology
4. PIR Sensor Component
 - a. Shall utilize pulse count processing and digital signature analysis to respond only to those signals caused by human motion.
 - b. Provide high immunity to false triggering from RFI and EMI.
 - c. Shall have a multiple-segmented fresnel lens in a multiple-tier configuration, with grooves to eliminate dust and residue buildup. Sensor shall be capable of accepting mask inserts to mask specific portions of the lens to prevent false triggering.
5. Ultrasonic Sensor Component
 - a. Detection Frequency (Small Area – 500 sq. ft. and less): Ultrasonic operating frequency shall be crystal controlled at 40 kHz within +/- 0.005% tolerance to assure reliable performance and eliminate sensor cross-talk.
 - b. Detection Frequency (Medium and Large Areas – greater than 500 sq. ft.): Ultrasonic operating frequency shall be crystal controlled at 32 kHz within +/- 0.005% tolerance, to assure reliable performance and eliminate sensor cross-talk.
 - c. Sensors shall be capable of automatically adapting to airflow conditions or filtering frequency spectrum related to air movement.
6. Detection Coverage: As indicated in Lighting Control Device Schedule on Drawings.

2.02 SWITCHBOX MOUNTED LINE VOLTAGE OCCUPANCY SENSORS

- A. In the Lighting Control Device Schedule, where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 1. Basis-of-Design Product: The specified occupancy sensor is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the schedule.
- B. General Description for Sensors: Line voltage occupancy sensor, suitable for mounting in a single gang switchbox.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
 4. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied. PIR senses motion using infrared heat detection. Dual technology sensors detect occupancy by using a combination of PIR and ultrasonic detect methods. Particular technology or combination of technologies shall be field selectable by operating controls on unit.
 5. Single-gang wall box switch, 120/277VAC, vandal-resistant lens, integral sliding blinders or pre-cut tape strips to block sensor views, protrudes no greater than 0.50 inches from wall.

6. LED indicator for visual detection of motion, audible and/or visual alerts for pending shut-off, light level sensor, 180-degree field of view, major and minor motion coverage patterns confirmed per Nema WD7 guidelines.
 7. On Operation: Concealed, field-adjustable for auto-on or manual-on operation.
 8. Concealed, field-adjustable, "off" time-delay selector with multiple increments from 30 seconds up to 30 minute time delay.
 9. Adaptive technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
 10. Suitable for switching load types used, including fluorescent, incandescent, magnetic and electronic low voltage and motor load types. UL listed and labeled, zero-cross relay, no minimum load requirement, ground wire.
 11. Wall switch shall have no leakage of current to load and integral service switch to permit a maintained off for servicing of lamps for safety purposes
 12. Ambient Light-Level Override: Concealed, field-adjustable sensor from 10 to 150 FC. The switch prevents the lights from turning ON when the light level is higher than the set point of the sensor.
- C. Single relay wall switch occupancy sensors: Manufacturer and sensing technology as indicated in Lighting Control Device Schedule. Single relay for controlling loads or circuits, single pushbutton for manual on/off control of loads. Set pushbutton ON operation (manual or automatic) as indicated in the Lighting Control Device Schedule.
- D. Dual-relay wall switch occupancy sensors: Manufacturer and sensing technology as indicated in the Lighting Control Device Schedule. Two relays for controlling two independent loads or circuits, two push buttons for independent control of dual loads or circuits. Set first and second pushbutton ON operation (manual or automatic) as indicated in the Lighting Control Device Schedule.
- E. Dual-technology wall switch occupancy sensors:
1. For new construction: Dual-technology wall switch sensor shall have not more than 0.5ma leakage of current to ground per UL requirements. Provide and connect a neutral conductor to these devices.

2.03 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.01 INSTALLATION

- A. GENERAL
 1. Install in accordance with manufacturer's instructions.
- B. SENSORS
 1. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage areas specified in manufacturer's literature. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate

only the rooms or areas that are to be provided with sensors. Provide additional sensors as required to properly and completely cover the respective areas.

2. 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.
3. Occupancy sensors with ultrasonic or dual-technology sensing technologies shall be located not closer than 4 feet from an air supply device.
4. Arrange a pre-installation meeting with manufacturer's factory authorized field representative, at Owner's facility, to verify placement of sensors and installation criteria.
5. Install devices and auxiliary equipment in compliance with manufacturer's instructions and recommendations.
6. Install relay units where concealed from view and where accessible.
7. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
8. Install switchbox mounted occupancy sensors at 44 inches above finished floor (Dimension is to the BOTTOM of the outlet box unless noted otherwise).

C. CONTACTORS

1. 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.

D. WIRING

1. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).
2. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
3. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
4. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.02 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
1. Power and control wiring: Identify using marker tapes.
 - a. Identify controlled circuits in lighting contactors.
 - b. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
 2. Components:
 - a. Identify using the following method:
 - 1) Self-laminating Computer Printed Labels.
 - 2) Engraved, Laminated Acrylic or Melamine Label.
 - 3) Permanent Ink.
 - b. Label each component with a unique designation matching control drawings.

3.03 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.

2. Operational Test: Test all occupancy sensors in test mode to confirm sensor coverage and sensitivity of sensor per manufacturer's instructions. Upon completion of tests, set sensor time delay as indicated on Lighting Control Device Schedule. Follow testing and adjustment procedures as written in the manufacturer's installation instructions for each sensor model.

B. Lighting control devices that fail tests and inspections are defective work.

3.04 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.05 TRAINING

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Lighting Controls."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 09 23

SECTION 26 22 00 LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1500 kVA:
 - 1. Distribution transformers.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

1.03 SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, technical certification sheets and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Transformer ratings including:
 - a. kVA
 - b. Primary and secondary voltage
 - c. Taps
 - d. Basic impulse level (BIL) for equipment over 600 volts
 - e. Design impedance
 - f. Insulation class and temperature rise
 - g. Sound level.
- C. Qualification Data: For testing agency.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."
- E. Transformers shall meet the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment".
- F. All transformers shall be UL listed and bear the UL label.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Products.
 - 2. Square D; Schneider Electric.

2.02 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: One leg per phase. Cores shall be constructed of high grade, non-aging silicon steel. The core and coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. The completed core and coil shall be bolted to the base of the enclosure but isolated by means of rubber, vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor or strap sized in accordance with UL and NEC requirements. The neutral shall be brought to a stud to facilitate the required external grounding of the secondary
- C. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Aluminum.
- D. Connections to transformers shall be by flexible metal conduit and using flexible couplings.
- E. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.
- F. Wiring/Terminations:
 - 1. Recommended external cable shall be rated 90 degrees C (sized at 75 degrees C ampacity) for encapsulated and 75 degrees C for ventilated designs.
 - 2. Connectors should be selected on the basis of the type and cable size used to wire the specific transformer.
 - 3. Lug kits shall be provided by the Manufacturer of the transformer.

2.03 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Enclosures: Unless otherwise specified, transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. Enclosures shall have a baked polyester powder coat finish-gray in color and suitable for interior or exterior applications. Enclosures

shall be constructed so that there are no exposed live parts. Enclosures shall have a removable front cover to allow access to internal parts and wiring terminations

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
 2. Transformer locations:
 - a. Dry locations:
 - 1) Ventilated
 - 2) NEMA 250, Type 2.
 3. The maximum temperature of the enclosure shall not exceed 90 degrees C.
 4. The maximum temperature of the top of the enclosure shall not exceed 50°C rise above a 40°C ambient.
- C. Transformer Enclosure Finish: Comply with NEMA 250.
1. Finish Color: ANSI 61 gray.
- D. Taps
1. Transformers 25 kVA through 500 kVA:
 - a. Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- E. Insulation Class for transformers 15 kVA and larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature
- F. Mounting Methods.
1. Transformers 75 KVA and larger shall be floor mounted unless indicated otherwise. Transformers 45 KVA and smaller may be wall mounted where wall construction is suitable for the load. Floor mounted transformers shall be securely bolted to a 4 inch housekeeping pad with vibration isolation pads. Wall mounted or suspended transformers shall have a means of isolating vibration from the support.
 2. Wall Mounting: Manufacturer's standard brackets.
 3. Suspended Mounting: See transformer mounting detail on plans.
- G. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.
1. 9 kVA and Less: 37 dBA
 2. 10 to 50 kVA: 42 dBA
 3. 51 to 150 kVA: 47 dBA
 4. 151 to 300 kVA: 52 dBA
 5. 301 to 500 kVA: 57 dBA
 6. 501 to 700 kVA: 59 dBA
 7. 701 to 1000 kVA: 61 dBA
 8. 1001 to 1500 kVA: 62 dBA

2.04 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to ANSI C57.12.01 and IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

2.05 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
 1. Ratio tests at the rated voltage connection and at all tap connections
 2. Polarity and phase relation tests on the rated voltage connection
 3. Applied potential tests
 4. Induced potential test
 5. No-load and excitation current at rated voltage on the rated voltage connection

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Floor mounted transformers shall be mounted on a 3-1/2 inch concrete housekeeping pad 2 inches larger all around transformer.
- C. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- D. Use flexible conduit under the provisions of Division 26 Section "Raceways and Boxes for Electrical Systems" for connections to transformer case. Minimum flexible conduit length shall be two (2) feet.
- E. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
- F. CONNECTIONS
 - 1. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 2. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.03 IDENTIFICATION

- A. Nameplates: Label each transformer with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems." Nameplates shall be engraved with the following information
 - 1. Transformer name
 - 2. Fed from (primary source)
 - 3. Secondary voltage, phase, wires
- B. Warning Labels: Label each panelboard with a warning label indicating NFPA 70 workspace clearance requirements, complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.04 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. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.

- D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
 - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
 - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.05 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.06 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 00

SECTION 26 24 16 PANELBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Lighting and appliance branch-circuit panelboards.

1.02 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. SPD: Transient voltage surge suppressor.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.04 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 6. Include wiring diagrams for power, signal, and control wiring.
 - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit electronic files, in an SKM-compatible format.
- C. Qualification Data: For qualified testing agency.
- D. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panelboard Schedules: Submit final panelboard directories.
- F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. 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.
- D. 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.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

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 according to NEMA PB 1.

1.07 FIELD CONDITIONS

- A. Interruption of Existing Electric Service: Do not interrupt electric service to occupied facilities. Refer to Division 26 Section "General Electrical Requirements" for allowable outages.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within the following time period:
 - 1. Warranty Period: Five years from date of Substantial Completion.

1.01 INTERRUPTION OF EXISTING ELECTRICAL DISTRIBUTION SYSTEMS:

- A. Refer to Division 26 Section "General Electrical Requirements" for procedures regarding interruption of electrical systems.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. Square D; a brand of Schneider Electric.
- B. Enclosures: Flush- or surface-mounted cabinets as noted.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Hinged Front Cover: Entire front trim hinged to box.
 - 3. Door: Standard door with concealed hinges, within hinged trim cover. Secured with vault-type latch with tumbler lock; keyed alike.
 - 4. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.

- 5. Directory Card: Inside panelboard door, mounted in transparent card holder.
- C. Incoming Mains Location: Top and/or bottom as required.
- D. Buses: Three phase, four wire unless otherwise indicated.
 - 1. Phase, and Neutral Buses:
 - a. Material:
 - 1) Tin-plated aluminum.
 - a) Hard-drawn copper, 98 percent conductivity, may be substituted if provided at no additional cost.
 - b. Size: Ampacity as indicated on drawings, with uniform capacity for entire length of panelboard's sections.
 - 1) Neutral bus: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus
 - 2. Ground Bus: Equipped with connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 - a. Material: Hard-drawn copper, 98 percent conductivity
 - b. Size: Minimum-size required by UL 891
- E. Connections: Provide compression type unless otherwise indicated on Drawings, refer to schedules and one-line diagram. Connections shall comply with requirements of Division 26 section "Low-Voltage Electrical Power Conductors and Cables".
 - 1. Feed-Through Lugs:
 - a. Locate at opposite end of bus from incoming lugs or main device.
 - 2. Subfeed (Double Lugs):
 - a. Locate at same end of bus as incoming lugs or main device.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating – Fully Rated: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.02 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. See manufacturers above.
- B. Panelboards: Circuit breaker type: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: As indicated on drawings.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

2.03 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. See manufacturers above.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. 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. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
5. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical type unless otherwise indicated on Drawings, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional with field-adjustable 0.1- to 0.6-second time delay.
 - g. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - i. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
 - j. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
 - k. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - l. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.04 ELECTRONIC-GRADE PANELBOARDS

- A. Surge Protection Device: See Panelboard Suppressor surge protection devices below.

2.05 SURGE PROTECTION DEVICES

- A. Provide surge protective devices as required by Division 26 Section "Surge Protective Devices".
- B. Panelboards requiring SPD and the location of the devices shall be as indicated on the Drawings.

2.06 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Wall-Mounted Panelboards: Install panelboards on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For panelboards not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Mount top of trim 72 inches (1788 mm) above finished floor unless otherwise indicated.
- E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- F. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- G. Install filler plates in unused spaces.
- H. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- J. Comply with NECA 1.

3.03 IDENTIFICATION

- A. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- C. Warning Labels: Label each panelboard with a warning label indicating NFPA 70 workspace clearance requirements, complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 - 1. Exception: Do not install on flush panelboards and similar equipment in finished spaces.
- D. Identify field-installed conductors, interconnecting wiring, and components; complying with Division 26 Section "Identification for Electrical Systems."
- E. Panel Directories
 - 1. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
 - 2. Note the date the directory was created/updated.
 - 3. Create directory after loads have been balanced.

3.04 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.05 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 24 16

SECTION 26 27 26 WIRING DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes the following:
 - 1. Receptacles: Single, duplex, USB/duplex, and ground-fault circuit interrupters (GFCI).
 - 2. AC Wall Switches: Single- and double-pole, three- and four-way, maintained and momentary, pilot light and lighted toggle, and dimmer
 - 3. Device Wall Plates.
 - 4. Multi-Outlet Assemblies.

1.02 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. IG: Isolated Ground
- C. PIR: Passive Infrared.
- D. RFI: Radio Frequency Interference
- E. SPD: Surge Protective Device

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Receptacles for Equipment Furnished by Owner or Under Other Divisions or Contracts: Match plug configurations.
- B. Coordinate requirements indicated in Division 26 Section "Equipment Wiring Systems".

1.04 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product data for the following products:
 - 1. Provide manufacturer's catalog information specifically marked to indicate which devices are being furnished, and showing dimensions, colors, and configurations for all devices, including, but not limited to: Receptacles, AC wall switches, and cover plates.
- C. Field quality-control test reports.
- D. Operations and Maintenance Data:
 - 1. Provide operating instructions for each type of dimmer.
- E. Warranty: Special warranties specified in this Section.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated cover plate from a single manufacturer and through one source. Where practical and possible, obtain all wiring devices and associated cover plates from a single manufacturer and one source.
- B. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 10 years.
- C. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that are acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.
- D. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.01 GENERAL

- A. Wiring devices are defined as single discrete units of electrical distribution systems, such as convenience receptacles, switches, special purpose receptacles, and similar, which are intended to carry, but not use electrical energy. Install wiring devices as required by the Specifications and where indicated on the Drawings.

2.02 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Receptacles and Switches:
 - a. Cooper Wiring Devices.
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Mfg. Company Inc.
 - d. Pass & Seymour/Legrand; Wiring Devices Div.
 - 2. Multioutlet Assemblies:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Wiremold Company (The).
- B. In other Part 2 articles below, where lists of manufacturers and device catalog numbers are included, the following additional requirements apply to product selection:
 - 1. Additional Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include manufacturers listed in individual articles below, in addition to those listed in Paragraph "Manufacturers" above.

2.03 FINISHES

- A. Color - normal power systems:
 - 1. Wiring devices:
 - a. Match existing devices, unless otherwise indicated or required by NFPA 70
 - 2. Cover plates:
 - a. Match existing cover plates
- B. Color - emergency power systems:
 - 1. Wiring devices:
 - a. Red
 - 2. Cover plates:
 - a. Match existing cover plates
- C. Color - Hospital grade receptacles:
 - 1. Wiring devices:
 - a. As specified above, with a green dot on its face.
 - 2. Cover plates:
 - a. As specified above
- D. Manufacturer's model numbers listed are to establish the quality of the wiring devices. Coordinate the proper suffixes in order to provide the correct color as specified above.

2.04 CONVENIENCE RECEPTACLE:

- A. The catalog numbers listed below are generally for 20A rated devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide receptacles equivalent to those specified for 20A, but rated for 15A.

- B. Hospital Grade straight blade receptacles: NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, nylon face, side and back wired, self-grounding.

<u>Manufacturer</u>	<u>Duplex</u>	<u>Single</u>
Cooper	8300	8310
Hubbell	HBK8300	HBL8310
Leviton	8300	8310
Pass & Seymour	8300H	8301

- C. Hospital Grade straight blade safety type, tamper-resistant receptacles: NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, nylon face, side and back wired, self-grounding.

<u>Manufacturer</u>	<u>Duplex</u>
Cooper	TR8300
Hubbell	HBL8300SGA
Leviton	8300-SG
Pass & Seymour	TR63HW

- D. USB/duplex convenience receptacles: NEMA 5-20R, 125V, 20A, tamper resistant, 3-wire, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding; with integral USB charger having two ports, USB 2.0 compatible, 5VDC, 3A output (min).

<u>Manufacturer</u>	<u>Single</u>
Cooper	TR7756
Hubbell	USB20X2
Leviton	T5832
Pass & Seymour	TR5362USB

2.05 GFCI RECEPTACLES

- A. Ground fault circuit interrupter type receptacles: Specification Grade or Hospital Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles downstream on the same circuit.

<u>Manufacturer</u>	<u>Specification Grade</u>	<u>Hospital Grade</u>
Cooper	VGF2	VGFH20
Hubbell	GF20LA	GFR8300HLA
Leviton	T7899-H	6898-HG
Pass & Seymour	2095	2095HG

- B. Ground fault circuit interrupter type weather-resistant receptacles: Hospital Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles downstream on the same circuit.

<u>Manufacturer</u>	<u>Hospital Grade</u>
Cooper	N/A
Hubbell	GFR8300HTR
Leviton	N/A

Pass & Seymour

N/A

2.06 SWITCHES

- A. The catalog numbers listed below are generally for 20A rated devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide switches equivalent to those specified for 20A, but rated for 15A.
- B. Switches: Commercial Specification grade, rated for 120/277V, 20A, back and side wired, and UL listed and labeled.

Manufacturer	1 Pole	2 Pole	3 Way	4 Way
Cooper	CSB120	CSB220	CSB320	CSB420
Hubbell	DS120	DS220	DS230	DS330
Leviton	CSB1-20	CSB2-20	CSB3-20	CSB4-20
Pass & Seymour	CS20AC1	--	CS20AC3	--

2.07 WALL BOX DIMMERS

- A. Wall box dimmers: UL listed and labeled, with Radio Frequency Interference (RFI) filters to avoid interference with electronic equipment.
1. Type as indicated on the Drawings.
 2. Wattage as indicated on the Drawings
- B. Dimmer shall be suitable for dimmed load type of connected light fixture, including incandescent, magnetic low voltage, electronic low voltage, fluorescent 2-wire, fluorescent 3-wire and fluorescent 4-wire. Load types shall be as indicated on Drawings and confirmed per load type for connected luminaire as indicated in Light Fixture Schedule and approved light fixture and dimmer shop drawings.

2.08 DUAL VOLTAGE SWITCH RELAY

- A. A normally-open, electrically-held relay that allows a single-pole switch to control loads operating at two different voltages (e.g., 120V and 277V); listed to UL Standard 916; installed in a 2-gang outlet box, with a voltage-separating barrier and plaster ring.

Manufacturer	Model Number
Lighting Controls and Design	GR 2001 DV – X

2.09 COVER PLATES

- A. Single and combination types to match corresponding wiring devices and manufacturer of wiring devices specified herein.
1. Plate securing screws: Metal with head color to match finish plate.
 2. Material for Finished Spaces:
 - a. Smooth nylon cover plates in finished areas.
 - b. Stamped steel for exposed areas.
 3. Material for Unfinished Spaces and surface mounted wiring devices: Galvanized steel.

4. Masonry walls and oversized wall openings: Jumbo size plates with same material as indicated above.
5. Refer to "Identification" below.

2.10 MULTI-OUTLET ASSEMBLIES

- A. Surface type "plug-in" strips: 3-wire, single circuit with single grounding type, 15A, 125V receptacles, pre-wired on 18-inch centers. Provide all fittings, devices, end closures, elbows, boxes and conduit entrance fittings as required for a complete installation.

Manufacturer	Extruded Aluminum	Steel
Polycarbonate		
Hubbell	HBL ALU20 Series	HBL 20GB Series
Polytrak Series		
Wiremold	--	V-2000 Series
		--

PART 3 - EXECUTION

3.01 GENERAL

- A. Outlets are only approximately located on the small scale Drawings. Use great care in the actual location by consulting the various large scale detailed Drawings used by other Division trades, and by securing definite locations from the Contract Administrator.
- B. Do not use multi-conductor circuits, with a shared neutral, for any GFCI receptacle circuit. Provide a separate neutral conductor with all GFCI receptacle circuits.
- C. Provide other special type receptacles where indicated on the Drawings.

3.02 EXAMINATION

- A. Verify existing conditions prior to beginning work.
- B. Verify that outlet boxes are installed at proper height and are flush with the finished surface.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.03 PREPARATION

- A. If required, provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from in and around outlet boxes.

3.04 INSTALLATION

- A. Install all wiring devices plumb, level, and square with building lines. Wiring device bodies shall extend to the finished surface of the walls, ceiling or floor, as applicable, without projecting beyond them.
- B. Connect wiring devices by wrapping conductors around screw terminals. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- C. Connect wiring device grounding terminal to branch circuit equipment grounding conductor and bond to metal outlet box. Exception: Do not bond grounding terminals of isolated ground receptacles to the outlet box.
- D. Install devices shown on wood trim, cases or other fixtures symmetrically and, where necessary, set with the long dimensions of the plate horizontal, or ganged in tandem.
- E. Unless dimensioned otherwise, install wiring devices a minimum of 24 inches from the closest edge of any sink.
- F. Install switches with OFF position down.

- G. Install wall dimmers to achieve full rating specified and indicated after de-rating for ganging as instructed by manufacturer.
- H. Where dimmer switches are shown adjacent to standard switches, install both in separate back boxes with adequate space between so that neither cover plate requires cutting. Dimmers shall not require de-rating. Do not remove fins.
- I. Provide a separate grounded conductor (neutral) for each circuit controlled by a dimmer. Do not share neutral conductor on load side of dimmers.
- J. Install cover plates on all switches, receptacles, and blank outlets.
- K. Locate wiring devices so that the cover plate does not have to be cut to be installed.
- L. Where devices are shown near wall openings, coordinate location if corner guards are to be installed so that cover plates do not require cutting.
- M. Install cover plates after the wall has been finished (painted, wall paper, etc).
- N. Install device boxes in brick or block walls such that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
- O. Provide Hospital Grade receptacles throughout the facility unless otherwise noted.
- P. Provide safety-type, tamper-resistant receptacles in all pediatric areas accessible to pediatric patients.

3.05 MOUNTING HEIGHTS

- A. Coordinate locations of outlet boxes provided under Division 26 Section "Common Work Results for Electrical".
- B. Unless otherwise noted, install wiring devices at mounting heights indicated in the Electrical Symbols Legend on the construction drawings.
 - 1. Receptacles:
 - a. General:
 - 1) Unless indicated otherwise, install vertically with the ground slot mounted at the top.
 - 2) Where Installed horizontally, install neutral slot mounted at the top.
 - b. Above counters:
 - 1) Mount vertically.
 - c. Mechanical and electrical equipment rooms and janitors closets: mount vertically.
 - d. Weatherproof exterior receptacles: mount vertically.
 - e. GFCI receptacles: Same as general receptacles.
 - f. Concrete Block Walls: Dimensions above may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom or top of boxes, as applicable, are at block joints.
 - 2. Switches:
 - a. Above counters: Same as for receptacles.
 - b. Concrete Block Walls: Dimension may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom of boxes are at block joints.
 - c. Walls with wainscoting: 6 inches minimum above wainscoting, but not exceeding 48 inches above finished floor.
 - 3. Multi-outlet assemblies (unless otherwise indicated on the Drawings):
 - a. 6 inches above counter top
 - 4. Telephone/Data Outlet Boxes:
 - a. General: Match mounting height of adjacent wiring device listed above.

3.06 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems", labels for wiring devices.

1. Unless indicated otherwise below, use the following method for all identification labels required in this section:
 - a. Engraved cover plates.
 - b. Engraved, Laminated Acrylic or Melamine Label.
2. Receptacles:
 - a. All receptacles in critical patient care locations shall be labelled using the following method:
 - 1) Engraved, Laminated Acrylic or Melamine Label.
 - b. In Public areas: Use permanent ink inside outlet boxes.
 - c. Identify panelboard and circuit number from which served.
 - d. Identify all receptacles fed downstream of GFCI protected receptacles as "GFCI PROTECTED".
3. Switches:
 - a. Use permanent ink inside back boxes.
 - b. Identify panelboard and circuit number from which served.
 - c. Refer to drawings for any additional labelling requirements.
4. Multi-Outlet Assemblies:
 - a. Identify panel and branch circuit.

3.07 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
- D. Test all wiring devices for electrical continuity and proper polarity of connections.
- E. Test each GFCI receptacle device for proper operation.
- F. Correct wiring devices incorrectly installed.
- G. Repair or replace all damaged items or damaged finishes at no expense to the Owner.

3.08 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.09 CLEANING

- A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 26 27 26

SECTION 26 28 13 FUSES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Section Includes:
 - 1. Cartridge fuses rated 600-V ac and less for use in:
 - a. Enclosed switches
 - 2. Plug fuses rated 125-V ac and less for use in plug-fuse-type:
 - a. Enclosed switches

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate fuse ratings with equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, 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 on translucent log-log graph paper if available.
 - 5. Coordination charts and tables and related data.
 - 6. Fuse sizes for elevator feeders and elevator disconnect switches.
- B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. All items requested under "Product Data".

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

1.05 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.06 EXTRA MATERIALS

- A. Furnish extra materials that match products installed. Deliver to Owner packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Edison Fuse, Inc.
 - 3. Mersen Electrical Power
 - 4. Littelfuse, Inc.

2.02 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

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. Feeders:
 - a. 600A or less:
 - 1) Class RK1, time delay
 - 2) Class RK1, fast acting
 - 3) Class J, fast acting
 - 4) Class J, time delay
 - 2. Motor Branch Circuits:
 - a. Class RK1 time delay
 - b. Class RK5, time delay
 - 3. Other Branch Circuits:

- a. Class RK1, time delay
- b. Class RK5, time delay
- c. Class J, fast acting
- d. Class J, time delay

3.03 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install plug-fuse adapters in Edison-base fuse holders and sockets. Ensure that adapters are irremovable once installed.

3.04 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 43 13 SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Section includes Surge Protection for:
 - 1. Panelboard Suppressors Internally Mounted In Panelboards
- B. Section includes field-mounted SURGE Protective Devices (SPD's) for low-voltage (120 to 600 V) power distribution and control equipment. Device type ratings shall be:
 - 1. Type 2 - Service entrances or distribution switchboards or panelboards
- C. Refer to Definitions below for clarification of type selection.

1.02 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. VPR: Voltage Protection Rating. The average of measured limiting voltage before and after Nominal Discharge Testing (I_n), rounded up to one of UL's VPR categories (Table 63.1 of ANSI/UL 1449 Third Edition) such as 330 volt, 400 volt, 500 volt, etc. VPR is posted on each device UL label.
- C. In or In or Inominal: Nominal Discharge Current. Peak value of surge current, selected by the manufacturer, through the SPD having current wave shape of 8/20 microseconds where the SPD remains functional after 15 surges. In is posted on the device UL label.
- D. SPD: Surge Protective Device. Previously Transient Voltage Surge Suppressor (TVSS), a broad class of protective devices, installed parallel with the distribution panel or service disconnect, meant to protect downstream electrical distribution equipment from the effects of high voltage surges on the line.
- E. MCOV: Maximum Continuous Operating Voltage. The maximum continuous operating voltage rating of a Metal Oxide Varistor (MOV) that can be applied without the MOV being damaged and/or destroyed by thermal runaway. MCOV is posted on the device UL label.
- F. SCCR: Short Circuit Current Rating. The maximum current rating the SPD can sustain without being damaged and/or destroyed. SCCR is posted on the device UL label.
- G. SPD Type:
 - 1. TYPE 1: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service equipment overcurrent device, as well as the load side, including watt-hour meter socket enclosures and intended to be installed without an external overcurrent protective device. Type 1 devices are required for Master Certification of Lightning Protection System installations under UL 96A.
 - 2. TYPE 2: Permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device, including SPDs located at the branch circuit panel.
 - 3. TYPE 3: Point-of-utilization SPDs, installed at a minimum conductor length of 10 meters (30 feet) from the electrical service panel to the point of utilization, e.g., cord-connected, direct plug-in, receptacle type and SPDs installed at the utilization equipment being protected. The distance (10 meters or 30 feet) is exclusive of conductors provided with or used to attach SPD's.
 - 4. TYPE 4: Component SPDs, including discrete components as well as component assemblies for installation on panelboards or control panels.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include model number, SPD type, system voltage, phases, modes of protection, voltage Protection rating (VPR), and Nominal Discharge Current (I_n), and accessories required.

- B. Qualification Data: For qualified testing agency.
- C. Product Certificates: For SPD devices, from manufacturer.
- D. Field quality-control reports.
- E. Operation and Maintenance Data: For SPD devices to include in emergency, operation, and maintenance manuals.
- F. Warranties: Sample of special warranties.

1.04 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member Company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled by UL or other Nationally Recognized Testing Laboratory (NRTL) as defined in NFPA 70, by a testing agency, and marked for intended location and application.
- C. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.
- D. Comply with NEMA LS 1.
- E. Comply with ANSI/ UL 1449 Third Edition.
- F. Comply with NFPA 70.
- G. The SPD shall be compliant with the restrictions of the Hazardous Substances (RoHS) Directive 2002/95/EC.

1.05 PROJECT CONDITIONS

- A. Service Conditions: Rate SPD devices for continuous operation under the following conditions unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
 - 3. Humidity: 0 to 85 percent, noncondensing.
 - 4. Altitude: Less than 20,000 feet (6090 m) above sea level.

1.06 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

1.07 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.01 PANELBOARD SUPPRESSORS INTERNALLY MOUNTED IN PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. Square D; a brand of Schneider Electric.
- B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating

matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:

1. Accessories:
 - a. LED indicator lights for power and protection status.
 - b. Audible alarm, with silencing switch, to indicate when protection has failed.
 - c. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
2. Accessories:
 - a. Fuses rated at 200-kA interrupting capacity.
 - b. Fabrication using bolted compression lugs for internal wiring.
 - c. Integral disconnect switch.
 - d. Redundant suppression circuits.
 - e. Redundant replaceable modules.
 - f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - g. LED indicator lights for power and protection status.
 - h. Audible alarm, with silencing switch, to indicate when protection has failed.
 - i. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 - j. Six-digit, transient-event counter set to totalize transient surges.
3. Peak Single-Impulse Surge Current Rating:
 - a. 160 kA per mode/320 kA per phase
 - b. 120 kA per mode/240 kA per phase
 - c. 80 kA per mode/160 kA per phase
4. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
 - a. Line to Neutral: 70,000A
 - b. Line to Ground: 70,000A
 - c. Neutral to Ground: 50,000A
5. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
6. Protection modes and UL 1449 SVR for grounded wye circuits with three-phase, four-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V	600Y/347 V
Line to Neutral	800	400	1200
Line to Ground	800	400	1200
Neutral to Ground	800	400	1200

7. Protection modes and UL 1449 SVR for 240/120-V, single-phase, three-wire circuits and for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:

	240/120V, 1ph, 3w	240/120V, 3ph, 4w (high leg)
Line to Neutral	400	400, 800 from high leg
Line to Ground	400	400
Neutral to Ground	400	400

8. Protection modes and UL 1449 SVR for three-phase, three-wire, delta circuits shall be as follows:

	240V	480V	600V
Line to Line	1000	2000	2500
Line to Ground	800	1500	2500

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install SPD devices at service entrance on load side, with ground lead bonded to service entrance ground.
- B. Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
 - 1. Provide multiple, 30-A circuit breaker as a dedicated disconnecting means for SPD unless otherwise indicated.

3.02 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
 - 1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
 - 2. After installing SPD devices but before electrical circuitry has been energized, test for compliance with requirements.
 - 3. Complete startup checks according to manufacturer's written instructions.
- E. SPD device will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.03 STARTUP SERVICE

- A. Do not energize or connect any equipment to their sources until SPD devices are installed and connected.
- B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to maintain SPD devices.
- B. Train Owner's maintenance personnel to maintain SPD devices.

END OF SECTION 26 43 13

SECTION 26 51 00 INTERIOR LIGHTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Included in the work of this section are labor, material, and appurtenances required to complete the work of this Section as specified herein, including, but not limited to:
 - 1. Interior light fixtures, lamps, LEDs, reflectors, lenses or faceplates, ballasts, transformers, drivers and power supplies
 - 2. Exit signs.
 - 3. Emergency lighting units.
 - 4. Light fixture supports.
 - 5. Coordination.
 - 6. Quality assurances.
 - 7. Specific requirements.

1.02 DEFINITIONS

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature
- C. CFL: Compact Fluorescent
- D. CRI: Color-rendering index.
- E. CU: Coefficient of utilization.
- F. EISA: Energy Independence and Security Act of 2007.
- G. HID: High-intensity discharge.
- H. L70: minimum 70% maintained initial-rated lumens at average rated life for LEDs
- I. LED: Light Emitting Diode
- J. LED Lamp: Replaceable LED light source with an integral driver within envelope of lamp. Lamp/Base types may include MR16/bi-pin, PAR/medium base, etc.
- K. LED Module: Light source that contains LEDs, and may include additional components such as lenses, reflectors, or refractors, however do not include drivers.
- L. LER: Light fixture (Luminaire) efficiency rating.
- M. Light Fixture: Complete light fixture, including ballast housing if provided.
- N. RCR: Room cavity ratio.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Unless otherwise noted, perform all electrical Work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.
- B. Coordinate layout and installation of light fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including, but not limited to, HVAC equipment, fire-suppression system, and partition assemblies. Contractor shall arrange his installation in proper relation to other work so that there shall be no interference, damage or delay to other trades' work.
- C. Give ample notice of any special openings or rough-in work required for placing electrical/lighting work so as to avoid cutting or removal of completed work.
- D. Where work of this Section is to be flush or concealed, install it so it does not project beyond finished lines of walls, ceilings or floor surface.

- E. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.

1.04 SUBMITTALS

A. General:

1. Only those light fixtures and manufacturers per each fixture type designated and listed in the Light Fixture Schedule or on the Drawings, and approved in accordance with paragraph 1.05 -SUBSTITUTIONS of this Section, or both, will be accepted. Where the Light Fixture Schedule indicates an allowance to be made for a specific light fixture, the price is a contractor price and monies shall be allotted for freight, installation, and lamping (if designated). Alternate manufacturers presented at bid shall be disqualified.
2. Submit all light fixtures, specified for use on this Project, in a single submittal package of portfolios, so that all light fixtures can be reviewed at one time.
3. Prepare portfolios from manufacturer's standard specification sheets, and include the fixture tag indicated on the Light Fixture Schedule to identify each light fixture. Do not combine more than one light fixture type on a single sheet.
4. Fixture or other materials shall not be shipped, stored, or installed into the work without approval of shop drawings.
5. Modifications to fixtures shall be in accordance with Contract Administrator's comments.

B. Product Data: For each type of light fixture, collated and bound in sets, and arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Summary page with the following for each light fixture type
 - a. The number, type and wattage of the light fixture lamps or LEDs (including, but not limited to, assemblies, arrays, bars or modules).
 - b. Light fixture ballast, driver or auxiliary device manufacturer, number and type.
2. Fixture cut sheets with name of manufacturer and options to be provided marked, including, but not limited to, voltage, lensing, and finish/color.
 - a. Descriptive information providing physical characteristics of light fixture, including, but not limited to, materials, dimensions, fixture efficacy and/or efficiency, and verification of indicated parameters.
 - b. For LED fixtures, include also L70 lifetime and wattage of luminaire including driver/power supply losses.
 - 1) Include MacAdam ellipse step information for:
 - a) All interior light fixtures
3. Light fixture mounting details, including non-standard outlet boxes.
4. Construction of light fixture housing and door (if applicable).
5. Ballast cut sheet with options marked, providing physical description of ballast including, but not limited to, voltage, lamp, ballast factor, power factor, amperage and wattage.
6. Power supply, transformer, and/or driver cut sheet with options marked, providing physical description of auxiliary device including, but not limited to, voltage, power factor, amperage, wattage, and maximum remote distance charts between device and light fixture.
7. Light fixture finish and color (if applicable).
8. Lamp cut sheet with options marked, providing physical description of lamps, including, but not limited to, voltage, wattage, efficacy, CCT, CRI, lumens, and life expectancy.
 - a.
 - b. For LED lamps, include also number of MacAdam ellipse steps and L70 lifetime.
9. Photometric data, in IESNA format, including LM-79 for LED luminaires, based on laboratory tests of each light fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the light fixture as applied in this Project.

- a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
 - b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
10. Emergency ballast cut sheet: Descriptive cut sheets providing physical description of emergency ballasts for use in normal light fixtures, including, but not limited to, complete battery information, lumens, and method for testing per NFPA 101.
- C. Shop Drawings: Show details of non-standard or custom light fixtures. Indicate dimensions, finish color, including, but not limited to, custom color, weights, methods of field assembly, components, features, accessories, and modifications. Scaled documents shall be provided for custom fixtures.
- D. Submittal Schedule
 1. Within 30 days of Division 26 contractor award, shop drawings covering all light fixtures within this section shall be forwarded to Contract Administrator to begin approval process. Any shop drawings submitted after the required time frame will require the contractor to submit only the 1st named manufacturer and associated specification data listed on the fixture schedule as the only approved manufacturer. No substitutions will be allowed after the specified time frame.
 2. Within 15 days of "approved" and "approved as noted" shop drawings, contractor shall forward to Contract Administrator a guaranteed ship date for each specified fixture.
 3. Within 15 days after contractor's receipt of "reject and resubmit" or "not approved" shop drawings, contractor shall provide Contract Administrator with resubmitted shop drawings for only those fixtures deemed unacceptable.
 4. Contractor is responsible to call to the attention of the Contract Administrator any submittals that have not been returned to him in a timely manner that may affect delivery of fixtures or as otherwise affecting Section 1.4.D of this specification.
- E. Control Wiring
- F. Coordination Drawings: Refer to architectural reflected ceiling plans or details for exact location of light fixtures; engineering documents shall not be referenced for exact fixture positions. Contractor shall check and verify dimensions and details on drawings before proceeding with the work. If any question arises about the true meaning of drawings, refer the matter to the Contract Administrator, whose decision is final. In no case proceed with work with any uncertainty. Architectural documents shall show and coordinate with assistance from installers of items involved:
 1. Light fixtures.
 2. Suspended ceiling components.
 3. Structural members to which suspension systems for light fixtures will be attached.
 4. Other items in finished ceiling including the following:
 5. Air outlets and inlets.
 6. Speakers.
 7. Sprinklers.
 8. Smoke and fire detectors.
 9. Occupancy sensors.
 10. Access panels.
 11. Perimeter moldings.
- G. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

- H. Qualification Data: For agencies providing photometric data for light fixtures.
- I. Field quality-control test reports.
- J. Operation and Maintenance Data: For lighting equipment and fixtures to include in operation and maintenance manuals.
- K. Warranties: Special warranties specified in this Section.

1.05 SUBSTITUTIONS

- A. Refer to Division 26 Section "General Electrical Requirements".
- B. Prior to the Bid Date, substitutions will not be considered unless the Contract Administrator/Engineer have received written request for approval at least ten calendar days prior to the date for receipt of Bids. Include in each such request the Light Fixture Schedule designation, name of the material or equipment for which it is to be substituted and complete Product Data for the proposed substitute, as defined in SUBMITTALS above, and all other information necessary for an evaluation. Provide interior point-by-point calculations, under both normal and emergency lighting conditions, as applicable, if required by the Engineer. Submit a \$100.00 review fee to the Engineer with each such point-by-point calculation for use of electronic base files. The fee will be returned if the substitution is added to the specification.
- C. During the Bid
 - 1. Any proprietary, sole-sourced light fixture listed in the fixture schedule shall be unit priced only. Unit prices shall be clearly identified on the bid form.
 - 2. Representative agents shall be allowed to offer mini-lot pricing (MLP). MLP shall be defined as:
 - a. Agents can group only specified fixtures they represent, and only represent in the region where the specification originated, and exclude all fixtures outside their represented lines from the MLP, and sole-sourced (proprietary) light fixtures shall not be included in the MLP.
- D. Packaging of light fixtures will not be considered nor approved. Packaging is defined as: distributor(s) providing a single price for a light fixture package made up of specified and non-specified light fixtures. Any submittal package containing non-specified light fixtures or inclusion of lighting control systems will be immediately rejected in its entirety.
- E. After the Bid Date, proposals to substitute light fixtures for those shown on the Drawings or specified herein, will only be considered as a deduct. Submit proposed substitutions separately, in Submittal form, with a list of proposed substitutions together with a deduct price for each substitution. Proposed substitutions will then be reviewed by the Contract Administrator/Engineer.
- F. During the construction period, no substitutions shall be considered if product delay is due to contractor's failure to order products in a timely manner after presentation of fixture schedules and specifications. Additional costs associated with air freight or special factory runs to meet schedule due to contractor's error shall be at the expense of contractor.
- G. The Contract Administrator/Engineer has the final authority as to whether the light fixture is an acceptable replacement to the specified item. The proposed substitution may also be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions herein described are rejected, provide the specified item(s).

1.06 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.
- B. Comply with NFPA 70.

- C. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- D. Regulatory Agencies: Provide fixtures conforming to nationally- or internationally-recognized accredited testing agencies, such as U.S., ETL, ARL, or others in acceptance with local code enforcement policy.
- E. Electrical Components and Devices: Provide only fixtures that comply with National Electric Code (NEC), and in particular to Section 410. All ceiling recessed fixtures, whether indicated in a catalog number or not, shall be equipped with an integral thermal protection device.

1.07 WARRANTY

- A. General Guarantee: For a period of one year after Owner's initial acceptance and establishment of the beginning date of the guarantee period, and at no cost to the Owner, Contractor shall promptly furnish and install replacements for any fixtures or components deemed by the Owner as defective in workmanship under normal operating conditions. Contractor shall repair installed equipment on the job site to Owner's satisfaction. For any time during said guarantee period that fixtures are not fully functional due to defects in material or workmanship, Contractor shall provide or pay for suitable temporary light fixtures, and shall remove said temporary fixtures upon installation of replacement elements. Contractor shall furthermore guarantee replacement fixtures for a period of one year following replacement.
- B. Contractor shall not be held responsible for damage of fixtures or equipment components occurring after the beginning of the guarantee period due to acts of vandalism, acts of war, or acts of God.
- C. LED Warranties: Shall be free from defects in materials and workmanship for the period indicated from date of factory shipment.
 - 1. LED Luminaires, including LED modules, arrays and drivers: Five years.
 - 2. LED Lamps: Three years.

1.08 EXTRA MATERIALS

- A. Where light fixtures are specified with tamper proof hardware, provide the Owner with three tools for each different type of hardware.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. In Light Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Basis-of-Design Product: The design for each light fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified that meets or exceeds performance characteristics of the named product.

2.02 LIGHT FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Provide light fixtures as shown on the drawings and/or specified. This shall include all lamps, material and labor to securely hang light fixtures, clean them and make them completely ready for use. Provide all hangers, supports, and miscellaneous hardware required to install light fixtures. Provide additional tie wires connected to structure to conform to applicable seismic requirements where required.
- B. Light fixture models scheduled on the Drawings are to show the manufacturer, grade and style of light fixtures required. Regardless of the manufacturer's catalog number suffixes indicated, provide all options and features as described in the Light Fixture Schedule.
- C. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures. Manufacturer of recessed fixtures shall provide mounting brackets suitable for connection to

ceiling system structure. Modifications to standard mounting brackets shall be coordinated with contractor and delivered with fixture so that no delays to product delivery shall be allowed.

- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- G. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metallized Film: 90 percent.
- H. Plastic Diffusers, Covers, and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass, unless otherwise indicated.
- I. Where located within structural concrete, light fixture housing and any other luminaire components in direct contact with concrete shall be effectively coated and/or covered to prevent chemical reactions with the concrete in accordance with the American Concrete Institute Code.
- J. Fixture Finishes:
 - 1. Apply fixture finishes after fabrication in a manner that assures a durable wear-resistant surfacing. Give exposed metal surfaces (brass, bronze, aluminum and others) and finished castings, except chromium-plated or stainless steel parts, an even coat of high-grade meth/acrylate lacquer or transparent epoxy.
 - 2. For corrosive or salt water environments, manufacturer shall provide fixtures with low copper/zinc cast aluminum (AB-47100 aluminum with less than 0.6% copper – classified for corrosive areas) housings to prevent salts from “pitting” aluminum housing. Manufacturer shall provide, in addition to or in lieu of, AB-47100 aluminum, ion added or pre-anodized polyester powder cast finish for “marine grade” applications. Manufacturer shall otherwise provide all stainless steel housing in conjunction with stainless steel hardware.
 - 3. Recessed downlights in corrosive or salt water interior environments shall be equipped with a “natatorium” finish comprised of a zinc-chromated and phosphated process, then powder-coated on the exterior of the housing.
- K. Reflectors:
 - 1. Provide aluminum reflectors or reflecting cones for downlight style fixtures comprised of #12 aluminum reflector sheet, 0.57 inch (15 gauge) or heavier and free of tool-making indentations, including spinning lines caused by assembly techniques. All reflectors shall be of first-quality, anodized finish Alzak” with specular or semi-specular finish and color as selected. Provide specular reflectors with no apparent brightness above 45 degrees from Nadir and semi-specular, diffuse reflectors with no apparent brightness above 75 degrees from Nadir.
- L. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps, LEDs, ballasts and/or drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp, LEDs, ballast and/or driver characteristics:
 - a. "USE ONLY" and include specific lamp or LED type.
 - b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires. Indicate maximum allowed wattage.
 - d. LED type, wattage, beam angle (if applicable) for LED luminaires. Indicate maximum allowed wattage.
 - e. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
 - f. ANSI ballast type (M98, M57, etc.) for HID luminaires.
 - g. CCT and CRI for all luminaires.

2.03 DRIVERS FOR LED LUMINAIRES

- A. Description: Designed for type and quantity of LED diodes of light fixture. Drivers shall tolerate sustained open circuit and short circuit output conditions without damage. Driver shall be designed for full light output unless dimmer or bi-level control is indicated:
 1. Sound Rating: A.
 2. Total Harmonic Distortion Rating: Less than 20 percent. Shall comply with ANSI C82.77.
 3. Transient Voltage Protection: IEEE C62.41, Category A or better.
 4. Power Factor: 0.90 or higher at full load.
 5. Interference: Comply with 47 CFR, Chapter 1, Part 15, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
 6. Driver shall operate with maximum sustained variations of +/-10% input voltage and frequency with no damage to driver.
 7. Driver output shall be regulated to maximum +/- 5% published load range or requirements of downstream LED fixture.
 8. LED Current Crest Factor: 1.5 or less.
 9. LED drivers shall not over-drive LEDs at a current or voltage above LED rated values in order to increase LED lumen output.
 10. Meets EN610000 for input harmonics.
 11. ROHS Compliant.
- B. Dimming Drivers:
 1. Dimming Range: Visually flicker-free, strobe-free, continuous dimming of source as follows, unless specifically noted otherwise in the Light Fixture Schedule whichever is more stringent:
 - a. Luminaires: 100 to 10 percent of rated lumens.
 - b. Lamps: 100 to 20 percent of rated lumens.
 2. 0-10V dimming drivers: Compliant with IEC 60929 standard for 4-wire dimming.
 3. Compatibility: Certified by manufacturer for use with specific dimming control system and LED indicated.
 4. Control: Coordinate to ensure that the dimming driver, power supply, controller, dimming module, and/or wall box dimmer and connecting wiring are compatible.

2.04 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
- C. Self-Luminous Signs: Powered by tritium gas, with universal bracket for flush-ceiling, wall, or end mounting. Signs shall be guaranteed by manufacturer to maintain the minimum brightness requirements in UL 924 for 10 years.

2.05 EMERGENCY LIGHTING UNITS

- A. Description: Self-contained units complying with UL 924.
 1. Charger: Fully automatic, solid-state type with sealed transfer relay.
 2. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 3. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 4. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 5. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.06 LAMPS GENERAL

- A. Unless specific manufacturers and lamp types are called for in the Light Fixture Schedule, all lamps provided for this project shall be by the same manufacturer. Lamps shall be manufactured by:
 1. Eiko
 2. General Electric
 3. Osram/Sylvania
 4. Philips
 5. Soraa
 6. Venture
- B. All lamps shall be new and shall be delivered to the project in manufacturer's original sealed package.
- C. Substitutions of specific lamp manufacturer as addressed in Light Fixture Schedule shall not be allowed. Costs associated with re-lamping due to non-compliance with specification, for both labor and material costs, shall be the sole responsibility of the contractor. For those fixtures with lamp included in fixture, contractor shall coordinate with manufacturer to ensure only approved lamp(s) is (are) installed. Lamp manufacturers indicated on Light Fixture Schedule are for reference. Where required, contractor shall coordinate with Owner regarding national purchasing agreement of specific lamp manufacturers. Purchasing of lamps, whether through competitive bidding of listed manufacturers or proprietary supply, shall be at the discretion of the Owner.
- D. LED Lamps and luminaires
 1. Comply with ANSI C78.377 for white light LED color range. Unless noted otherwise in the Light Fixture Schedule, LED color quality characteristics shall be 80 CRI minimum and 4000K CCT.
 2. LED binning specification tolerance to be within 3 MacAdam ellipses of rated values or as indicated in the Light Fixture Schedule, whichever is more stringent. All LEDs used for same fixture type throughout the project to originate from same production bin.
 3. Unless indicated otherwise in the Light Fixture Schedule, minimum 70% maintained initial-rated lumens at average rated life of as follows:

- a. LED lamps: 20,000 hours
- b. LED luminaires: 50000 hours
- 4. ROHS compliant
- 5. Manufacturer of LED chips will be evaluated based on the manufacturer's product literature and data. At a minimum, LED fixtures or lamps will incorporate Bridgelux, Cree, Nichia, Osram or Xicato LEDs; additional manufacturers may be considered however the Contract Administrator or Engineer has the authority to reject other manufacturers for technical or aesthetic reasons if felt necessary or desirable.

2.07 AUXILIARY DEVICES FOR LOW VOLTAGE AND LED FIXTURES

- A. Provide remote power supplies, drivers and/or transformers for light fixtures as required for a complete and operational system. Where equipment is not indicated as plenum rated, provide an additional enclosure for the device(s) suitable for the installed environment.

2.08 TRANSFORMERS FOR LOW VOLTAGE FIXTURES

- A. Provide transformers to low voltage lamps, which are suitable for the electrical characteristics of the supply circuits to which they are to be connected. For remote electronic or magnetic transformers, contractor shall remote transformers to reduce voltage drop. For 25 amp low-voltage linear systems, contractor shall not daisy chain 25A loaded runs together. Contractor shall provide home run from end of run to remote transformer.

2.09 LIGHT FIXTURE SUPPORT COMPONENTS

- A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge.
- E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify conditions of equipment and installation prior to beginning work.
- B. Verify that equipment is ready for connecting, wiring, and energizing.

3.02 INSTALLATION

- A. Light Fixtures: All work shall be executed to present a neat appearance. Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Temporary Lighting: If it is necessary, and approved by Contract Administrator, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Support for Light Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
 - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from light fixture corners.
 - 2. Support Clips: Fasten to light fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
- D. Suspended Light Fixture Support:
 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end. Provide suitable connectors or collars to connect adjoining units to appear as a continuous unit.
 4. Decorative pendant mounted light fixtures
 - a. Provide cord and/or stem lengths to match elevations above finished floor as indicated on architectural elevations. If architectural elevations do not indicate suspension heights, coordinate with Contract Administrator to determine final suspension heights. Regardless, contractor shall not field cut pendants or order rigid stems without elevation approval from Contract Administrator. Pendant suspensions on electrical documents are for reference only.
 - 1) Cord-mounted: Manufacturers shall supply luminaires with flexible, field cutting cords. Contractor shall field cut cords as required.
 - 2) Field-cuttable, rigid-stem mounted: Manufacturers shall supply luminaires with field cutting rigid stems. Contractor shall field cut stems as required.
 - 3) Factory-cut rigid stem mounted: Contractor shall provide rigid stem dimensions to the manufacturer as required.
 - b. Junction boxes used to feed light fixtures shall be covered by manufacturer supplied canopy plates.
- E. Installation within non-standard ceilings, including, but not limited to, wood and metal ceilings.
 1. For recessed downlight light fixtures, specification is based on standard throats to accommodate ceiling thicknesses of 3/4" or less. If non-standard ceiling (such as wood, thickened gypsum board ceilings and metal plank type) require throats greater than 3/4", modifications to manufacturer's standard 3/4" throat shall be determined by Contract Administrator and Contractor prior to shop drawing submission.
 2. For light fixtures recessed into metal ceilings, rigidly support light fixture to ensure that trim fits flush with ceiling plane.
- F. Manufacturer shall supply contractor with a complete list of component elements to comply with design intent for either 20-amp (flexible low voltage track systems or line voltage track) or 50-amp bus bar track systems. Contractor shall install track systems based on design requirements outlined herein or Light Fixture Schedule.
- G. Through wiring of recessed light fixtures, in suspended ceilings, is not permitted. Connect each light fixture by a whip to a junction box. The whip shall be of sufficient length to allow the light fixture to be relocated within a 6-foot radius.
- H. Wall Mounted Light fixtures
 1. Unless otherwise noted, conceal all raceways and back boxes for wall mounted light fixtures. Coordinate all wall-mounted light fixtures with interior elevations. Where specific elevations or dimensions are not indicated, verify the correct location with Contract Administrator prior to installation. Contractor shall supply structure to support weight of fixture.
- I. Contractor shall construct light coves according to architectural details. Contractor shall ensure, unless otherwise directed, that top of fixture lamp is flush with top of cove lip. Contractor shall provide blocking as needed under fixture to ensure stated requirement.
- J. Auxiliary Devices for low voltage and LED Fixtures

1. Install device within maximum remote distances and with wiring sized per manufacturer's recommendations.
2. In public areas or other areas where remote device visibility is undesirable, install device where concealed from view, well ventilated and accessible. Provide access panels as required.
3. Provide label on device indicating fixture type and location/room served along with panelboard circuit number.
4. Properly support remote lighting devices, including transformers, power supplies, and drivers, per Code and manufacturer's recommendations.

3.03 DIMMING

- A. For dimmable light fixtures, provide both control and power wiring between light fixture and control device and between light fixtures. Quantity of low voltage and line voltage wiring and wire type shall be per manufacturer's recommendations. At a minimum, provide the following based on control type at either 120V or 277V, unless recommended otherwise by the manufacturer:
 1. 0-10V – two low voltage conductors and two line voltage conductors plus ground
- B. Coordinate light fixture and control device dimming types for compatibility.

3.04 COORDINATION

- A. Light fixtures shown on the Electrical Drawings represent general arrangements only. Refer to Architectural Drawings for exact locations.
- B. Coordinate the installation and location of light fixtures with other work and all other trades before installation to avoid conflicts. Coordinate light fixture locations in mechanical rooms with final installed piping and ductwork layouts.
- C. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.
- D. Wall-Mounted Light fixtures
 1. Coordinate all wall-mounted light fixtures with the architectural features of the building. Where specific elevations or dimensions are not indicated, verify the correct location with the Contract Administrator prior to beginning any work.

3.05 ADJUSTING

- A. Contractor shall adjust all light fixture sockets to match the lamp specified and aim all adjustable light fixtures as directed by the Contract Administrator.
- B. Where required, focusing shall be done during hours of darkness. Upon notification by contractor that all fixtures are correct as per shop drawings and functioning, that specified lamps have been verified, lighting designer or Contract Administrator shall coordinate with contractor as to a mutually agreed upon time to complete focusing. Failure of contractor to notify Contract Administrator during substantial completion will result in failure to comply with specifications.

3.06 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Clean light fixtures of dirt and debris upon completion of the installation. Protect installed light fixtures from damage during the remainder of the construction period.
- C. Upon completion of the installation of light fixtures, and after building circuits have been energized, energize lighting branch circuits to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- D. At the time of final acceptance of this project by the Owner, ensure that all lamps are in working order and all light fixtures are fully lamped.

- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.07 STARTUP SERVICE

- A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.08 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions (including lifts or ladders). Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
 - 1. Adjust aimable luminaires in the presence of Contract Administrator.

END OF SECTION 26 51 00

SECTION 26 56 00 EXTERIOR AREA LIGHTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes the following lighting equipment:
 - 1. Exterior LED light fixtures with LED modules and drivers.

1.02 DEFINITIONS

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature
- C. CFL: Compact Fluorescent
- D. CRI: Color-rendering index.
- E. CU: Coefficient of utilization.
- F. CV: Coefficient of Variance. The ratio of standard deviation for all illuminance values to the mean illuminance value.
- G. Delegated-Design Submittals: Documents, including, but not limited to, drawings, calculations, and material and product specifications prepared as a responsibility of Contractor to obtain acceptance by Owner and authorities having jurisdiction.
- H. EISA: Energy Independence and Security Act of 2007.
- I. HID: High-intensity discharge.
- J. Horizontal Illuminance: Measurement in foot-candles (lux), on a horizontal surface 36 inches above the ground, unless otherwise indicated.
- K. L70: minimum 70% maintained initial-rated lumens at average rated life for LEDs
- L. LED: Light Emitting Diode
- M. LED Lamp: Replaceable LED light source with an integral driver within envelope of lamp. Lamp/Base types may include MR16/bi-pin, PAR/medium base, etc.
- N. LED Module: Light source that contains LEDs, and may include additional components such as lenses, reflectors, or refractors, however do not include drivers.
- O. LER: Light fixture efficacy rating.
- P. Light fixture: Complete light fixture, including ballast housing if provided.
- Q. LLD: Lamp Lumen Depreciation.
- R. LLF: Light Loss Factor.
- S. Luminaire: Complete lighting fixture, including ballast housing if provided.
- T. Pole: Light fixture support structure, including tower used for large area illumination.
- U. Standard: Same definition as "Pole" above.
- V. Target Illumination: Average maintained illumination level, calculated by multiplying initial illuminance by LLF.
- W. UG: Uniformity Gradient; the rate of change of illuminance over a lighted area, expressed as a ration between the illuminances of adjacent measuring points on a uniform grid.
- X. Vertical Illuminance: Measurement in foot-candles (lux), in two directions on a vertical surface, at an elevation coinciding with plane height of horizontal measurements.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Unless otherwise noted, perform all electrical Work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these

Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

- B. Coordinate layout and installation of light fixtures, poles, foundations, and underground raceway system with other above- and below-grade site construction and utilities. Notify Contract Administrator of conflicts before proceeding with the Work.

1.04 SUBMITTALS

- A. General:

- 1. Only those light fixtures and manufacturers per each fixture type designated and listed in the Light Fixture Schedule or on the Drawings, and approved in accordance with paragraph 1.4-SUBSTITUTIONS of this Section, or both, will be accepted. Where the Light Fixture Schedule indicates an allowance to be made for a specific light fixture, the price is a contractor price and monies shall be allotted for freight, installation, and lamping (if designated). Alternate manufacturers presented at bid shall be disqualified.
- 2. Submit all light fixtures, specified for use on this Project, in a single submittal package of portfolios, so that all light fixtures can be reviewed at one time.

- B. Prepare portfolios from manufacturer's standard specification sheets, and include the number indicated on the Light Fixture Schedule to identify each light fixture. Do not combine more than one light fixture type on a single sheet.

- 1. Fixture or other materials shall not be shipped, stored, or installed into the work without approval of shop drawings.
- 2. Modifications to fixtures shall be in accordance with Contract Administrator's comments.

- C. Product Data: For each light fixture, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

- 1. Summary page with the following for each light fixture type
 - a. The number, type and wattage of the light fixture lamps or LEDs (including, but not limited to, assemblies, arrays, bars or modules).
 - b. Light fixture ballast, driver or auxiliary device manufacturer, number and type.
- 2. Fixture cut sheets with name of manufacturer and options to be provided marked, including, but not limited to, voltage, lensing, and finish/color.
 - a. Descriptive information providing physical characteristics of light fixture, including, but not limited to, materials, dimensions, effective projected area, fixture efficacy and/or efficiency, and verification of indicated parameters.
 - b. For LED fixtures, include also L70 lifetime and wattage of luminaire including driver/power supply losses.
 - 1) Include MacAdam ellipse step information for luminaires specified with 80 CRI or greater.
- 3. Light fixture mounting details, including, but not limited to, non-standard outlet boxes.
- 4. Construction of light fixture housing and door (if applicable).
- 5. Power supply, transformer, and/or driver cut sheet with options marked, providing physical description of auxiliary device including, but not limited to, voltage, power factor, amperage, wattage, and maximum remote distance charts between device and light fixture.
 - a. For dimming LED, also include dimming type technology and dimming range/limits.
- 6. Lamp cut sheet with options marked, providing physical description of lamps, including, but not limited to, voltage, wattage, efficacy, CCT, CRI, lumens, and life expectancy.
 - a. For LED lamps, include also number of MacAdam ellipse steps and L70 lifetime.
- 7. Details of attaching light fixtures and accessories.
- 8. Details of installation and construction.

9. Photometric data, in IESNA format, including LM-79 for LED luminaires, based on laboratory tests of each light fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the light fixture as applied in this Project.
 - a. For indicated light fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining light fixtures shall be certified by manufacturer.
 - b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
10. Materials, dimensions, and finishes of poles.
11. Means of attaching light fixtures to supports, and indication that attachment is suitable for components involved.
12. Anchor bolts for poles.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For light fixtures to include in operation and maintenance manuals.
- F. Warranty: Special warranties specified in this Section.

1.05 SUBSTITUTIONS

- A. Refer to Division 26 Section "General Electrical Requirements".
- B. Prior to the Bid Date, substitutions will not be considered unless the Contract Administrator/Engineer have received written request for approval at least ten calendar days prior to the date for receipt of Bids. Include in each such request the Light Fixture Schedule designation, name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including cut sheets, photometric data, and all other information necessary for an evaluation. Provide interior point-by-point calculations if required by the Engineer. Submit a \$100.00 review fee to the Engineer with each such point-by-point calculation for use of electronic base files. The fee will be returned if the substitution is added to the specification.
- C. During the Bid
 1. Any proprietary, sole-sourced light fixture listed in the fixture schedule shall be unit priced only. Unit prices shall be clearly identified on the bid form.
 2. Representative agents shall be allowed to offer mini-lot pricing (MLP). MLP shall be defined as:
 - a. Agents can group only specified fixtures they represent, and
 - b. Only represent in the region where the specification originated, and
 - c. Exclude all fixtures outside their represented lines from the MLP, and
 - d. Sole-sourced (proprietary) light fixtures shall not be included in the MLP.
 3. Packaging of light fixtures will not be considered nor approved. Packaging is defined as: distributor(s) providing a single price for a light fixture package made up of specified and non-specified light fixtures. Any submittal package containing non-specified light fixtures or inclusion of lighting control systems will be immediately rejected in its entirety.
- D. After the Bid Date, proposals to substitute light fixtures for those shown on the Drawings or specified herein, will only be considered as a deduct. Submit proposed substitutions separately, in Submittal form, with a list of proposed substitutions together with a deduct price for each substitution. Proposed substitutions will then be reviewed by the Contract Administrator/Engineer.
- E. The Contract Administrator/Engineer have the final authority as to whether the light fixture is an acceptable replacement to the specified item. The proposed substitution may also be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions herein described are rejected, provide the specified item(s).

1.06 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of light fixture and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in latest AASHTO LTS-4.
- B. Ice Load: As stated in latest AASHTO LTS-4 or as required by the local authority having jurisdiction, whichever is more stringent.
- C. Wind Load: As stated in latest AASHTO LTS-4 or as required by the local authority having jurisdiction, whichever is more stringent.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this project.
- B. Light Fixture Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with IEEE C2, "National Electrical Safety Code."
- E. Comply with NFPA 70.

1.08 WARRANTY

- A. General Guarantee: For a period of one year after Owner's initial acceptance and establishment of the beginning date of the guarantee period, and at no cost to the Owner, Contractor shall promptly furnish and install replacements for any fixtures or components deemed by the Owner as defective in workmanship under normal operating conditions, excluding lamp replacement as noted in Section 1.12.A.1. Contractor shall repair installed equipment on the job site to Owner's satisfaction. For any time during said guarantee period that fixtures are not fully functional due to defects in material or workmanship, Contractor shall provide or pay for suitable temporary light fixtures, and shall remove said temporary fixtures upon installation of replacement elements. Contractor shall furthermore guarantee replacement fixtures for a period of one year following replacement.
- B. Contractor shall not be held responsible for damage of fixtures or equipment components occurring after the beginning of the guarantee period due to acts of vandalism, acts of war, or acts of God.
- C. LED Warranties: Shall be free from defects in materials and workmanship for the period indicated from date of factory shipment.
 - 1. LED Luminaires, including LED modules, arrays and drivers: Five years.
 - 2. LED Lamps: Three years.
- D. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Light fixtures: Free from defects in materials and workmanship (excluding fuses and lamps) for a period of 5 years from date of Substantial Completion.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. In Light Fixture Schedule (on the drawings) where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Basis-of-Design Product: The design for each light fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified that meets or exceeds performance characteristics of the named product.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 LIGHT FIXTURES, GENERAL REQUIREMENTS

- A. Light fixtures shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IES RP-8 for parameters of lateral light distribution patterns indicated for light fixtures.
- C. Comply with IES BUG ratings where indicated on the Light Fixture Schedule.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed light fixtures.
- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- H. Exposed Hardware Material: Stainless steel for latches, fasteners, and hinges.
- I. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- J. Light Shields: Metal baffles or louvers, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- K. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.
- L. Gaskets for Lenses and Refractors: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in light fixture doors.
- M. Where located within structural concrete, light fixture housing and any other luminaire components in direct contact with concrete shall be effectively coated and/or covered to prevent chemical reactions with the concrete in accordance with the American Concrete Institute Code.
- N. Light Fixture Finish: Manufacturer's standard paint applied to factory-assembled and -tested light fixture before shipping. Where indicated, match finish process and color of pole or support materials.
- O. Factory-Applied Finish for Steel Light Fixtures: 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, "Solvent Cleaning," 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, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 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.

- a. Color: As indicated on the Light Fixture Schedule.
- P. Factory-Applied Finish for Aluminum Light Fixtures: 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 the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; 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; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
- a. Color: As indicated on the Light Fixture Schedule.
- Q. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps, LEDs, ballasts and/or drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp, LEDs, ballast and/or driver characteristics:
 - a. "USES ONLY" and include specific lamp or LED type.
 - b. LED type, wattage, beam angle (if applicable) for LED luminaires. Include maximum allowed wattage.
 - c. For LED luminaires, includes CCT and CRI.

2.03 DRIVERS FOR LED LUMINAIRES

- A. Description: Designed for type and quantity of LED diodes of light fixture. Drivers shall tolerate sustained open circuit and short circuit output conditions without damage. Driver shall be designed for full light output unless dimmer or bi-level control is indicated:
 - 1. Sound Rating: A.
 - 2. Total Harmonic Distortion Rating: Less than 20 percent. Shall comply with ANSI C82.77.
 - 3. Transient Voltage Protection: IEEE C62.41, Category A or better.
 - 4. Power Factor: 0.90 or higher at full load.
 - 5. Interference: Comply with 47 CFR, Chapter 1, Part 15, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
 - 6. Driver shall operate with maximum sustained variations of +/- 10% input voltage and frequency with no damage to driver.
 - 7. Driver output shall be regulated to +/- 5% published load range.
 - 8. LED Current Crest Factor: 1.5 or less.
 - 9. LED drivers shall not over-drive LEDs at a current or voltage above LED rated values in order to increase LED lumen output.
 - 10. Meets EN610000 for input harmonics.
 - 11. ROHS Compliant.
 - 12. Suitable for use in outdoor light fixtures.
 - 13. Dimming Drivers
 - a. Dimming Range: Visually flicker-free, strobe-free, continuous dimming of source as follows, unless specifically noted otherwise in the Light Fixture Schedule whichever is more stringent:
 - 1) Luminaires: 100 to 10 percent of rated lumens.

- 2) LED Lamps: 100 to 20 percent of rated lumens.
- b. 0-10V dimming drivers: Compliant with IEC 60929 standard for 4-wire dimming.
- c. Compatibility: Certified by the manufacturer for use with specific dimming control system and LED indicated.
- d. Control: Coordinate to ensure that the dimming driver, power supply, controller, dimming module, and/or wallbox dimmer and connecting wiring are compatible.

2.04 LED LAMPS AND LUMINAIRES

- A. Comply with ANSI C78.377 for white light LED color range. Unless noted otherwise in the Light Fixture Schedule, LED color quality characteristics shall be 70 CRI minimum and 4000K CCT. Additionally, color-important light fixtures, as indicated with 80 CRI or better the Light Fixture Schedule shall be 80 CRI minimum and 4000K CCT. All LEDs used for same fixture type throughout the project to originate from same production bin.
- B. LED binning specification tolerance to be within 3 MacAdam ellipses of rated values for color as indicated in the Light Fixture Schedule.
- C. Unless indicated otherwise in the Light Fixture Schedule, minimum 70% of maintained initial-rated lumens at the average rated life as follows:
 - 1. LED outdoor pole mounted area lights: 100,000 hours
 - 2. LED lamps: 20,000 hours
 - 3. Other LED luminaires: 50,000 hours
- D. ROHS compliant
- E. Manufacturer of LED chips will be evaluated based on the manufacturer's product literature and data. At a minimum, LED fixtures or lamps will incorporate Bridgelux, Nichia, Cree, Xicato or Osram LEDs; additional manufacturers may be considered however the Contract Administrator or Engineer has the authority to reject other manufacturers for technical or aesthetic reasons if felt necessary or desirable.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify conditions of equipment and installation prior to beginning work.
- B. Verify that equipment is ready for connecting, wiring, and energizing.

3.02 LIGHT FIXTURE INSTALLATION

- A. Install lamps in each light fixture.
- B. Fasten light fixture to indicated structural supports.
- C. Adjust light fixtures that require field adjustment or aiming.
- D. Baffles and Louvers for Spill Light Correction: Install on lighting fixtures with fasteners provided by the manufacturer. Install and adjust to correct out-of-limit spill-light measurements.
- E. Auxiliary devices for low voltage and LED fixtures installation
 - 1. Install device within maximum remote distances and with wiring sized per manufacturer's recommendations.
 - 2. In public areas or other areas where remote device visibility is undesirable, install device where concealed from view, well ventilated and accessible. Provide access panels as required.
 - 3. Provide label on device indicating fixture type and location/room served along with panelboard circuit number.
 - 4. Properly support remote lighting devices, including, but not limited to, transformers, power supplies, and drivers, per Code and manufacturer's recommendations.
 - 5. Provide enclosures suitable for installation environment as required.

3.03 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes for Electrical Systems", including use of coated conduits in concrete foundations.

3.04 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Adjust all light fixture sockets to match the lamp specified and aim all adjustable light fixtures as directed by the Contract Administrator.
- C. Upon completion of the installation of light fixtures, and after building circuits have been energized, apply electrical energy to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- D. Clean light fixtures of dirt and debris upon completion of the installation. Protect installed light fixtures from damage during the remainder of the construction period.
- E. At the time of Substantial Completion, aim all adjustable fixtures, such as flood and spotlights, per the Contract Administrator's direction. Provide all necessary equipment to support this effort, such as scaffolds and lifts, as required.
- F. At the time of Final Acceptance of this Project by the Owner, all lamps shall be in working order and all light fixtures shall be fully lamped.
- G. Illumination Observations: Verify normal operation of lighting units after installing light fixtures and energizing circuits with normal power source.

END OF SECTION 26 56 00

SECTION 284600 FIRE DETECTION AND ALARM

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.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.
 - 2. Division 26 Section "Common Work Results for Electrical," for materials and methods for coordination, sleeves and common installation requirements.

1.02 DESCRIPTION OF WORK

- A. This Section requires the Contractor to furnish all materials required to install the fire alarm system. The Contractor shall be responsible for installing, testing, and start-up of a complete functioning fire alarm system, and each element thereof, as specified or indicated on the Drawings or reasonably inferred, including every article, device or accessory (whether or not specifically called for by item) necessary to facilitate each system's function as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation and utilities.
- B. Division 28 of the Specifications and Drawings numbered with prefixes FX generally describe these systems, but the scope of the Fire Alarm work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Fire Suppression, Mechanical, Plumbing, Fire Alarm and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically and are intended to convey the scope of work, indicating the general location and arrangement of the major equipment, devices, appliances, etc. without showing all the exact details as to elevations, circuits, routing, and other installation requirements. Use the Drawings as a guide when laying out the system and verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. The scope of work in this section includes:
 - 1. Manual fire alarm pull stations
 - 2. System smoke detectors
 - 3. Notification appliances
 - 4. Sprinkler system waterflow and valve tamper alarms
 - 5. Magnetic door holders
 - 6. Air handling unit shutdown
 - 7. Battery stand-by power
 - 8. Multi-channel one-way voice notification system

1.03 QUALITY ASSURANCE

- A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturer's requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.
- D. Installation of devices shall be performed or supervised by a National Institute for Certification of Engineering Technologies (NICET) Level 2 or higher Fire Alarm Technician. Submit copies of the certification for employees through shop drawing submittals.

1.04 APPLICABLE CODES AND STANDARDS

- A. Execute Work in accordance with the National Fire Protection Association Standards and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities. Upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.
- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.
- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.
- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes.
 - 1. NFPA 70, "National Electrical Code", 2011 Edition.
 - 3. NFPA 72, "National Fire Alarm and Signaling Code", 2010 Edition.
 - 4. NFPA 101, "Life Safety Code", 2012 Edition.
 - 5. Underwriters Laboratories, "Fire Protection Equipment Directory", Latest Edition.
 - 6. HCA Healthcare Design and Engineering Guidelines for Hospitals, 2021 Edition
 - 7. International Fire Code (IFC) 20xx Edition with local amendments.
- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

1.05 DEFINITIONS

- A. General:
 - 1. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."
 - 2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
 - 3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."
 - 4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
 - 5. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the AHJ over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
 - 6. FACP: Fire Alarm Control Panel.

- 7. NICET: National Institute for Certification in Engineering Technologies.
- 8. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
- 9. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

1.06 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.
- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping in the manner anticipated in the design.
- C. The Contractor shall maintain a foreman on the jobsite at all times to coordinate their work with other contractors and subcontractors so that various components of the Fire Alarm systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the work in such a manner that the work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.
- D. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and their subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.
- E. Where coordination and interfacing with other systems or equipment is required, it shall be the responsibility of the fire alarm system installer (contractor) to either provide the relays, contacts, power supplies and other necessary hardware or see to it that such hardware is provided with the other systems or equipment.
- F. The contractor shall coordinate work in this section with all related trades. Work and/or equipment provided in other sections and related to the fire alarm system shall include, but not be limited to:
 - 1. Sprinkler waterflow and valve tamper switches shall be provided by the fire sprinkler installer, but wired and connected by the fire alarm installer.
 - 2. Duct smoke detectors shall be furnished, wired and connected by the fire alarm system installer. The HVAC installer shall furnish necessary duct opening to install the duct smoke detector's housing.
 - 3. Air handling fan control circuits and contacts to be furnished by the HVAC control equipment.
 - 4. Conduit shall be by Division 26 "Common Work Results for Electrical".
- G. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.07 MEASUREMENTS AND LAYOUTS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.08 SUBMITTALS

- A. Refer to Division 1 and General Conditions for submittal requirements, in addition to requirements specified herein. Submittals not complying fully with the submittal requirements will be rejected.
- B. Contractor shall prepare installation drawings (working shop drawings) based upon this design. Requests for deviations from the approved design shall be submitted in writing to the Engineer of Record for approval.
- C. Shop drawings shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code and relevant laws, ordinances, rules and regulations. Drawings that are not legible, or that do not contain sufficient detail to verify compliance with applicable codes and standards, will be rejected without further review.
- D. Submittals and shop drawings shall not contain HEI's firm name or logo, nor shall it contain the HEI's engineers' seal and signature. They shall not be copies of HEI's work product. If the contractor desires to use elements of such product, the license agreement for transfer of information at the end of this section must be used.
- E. Submit Shop Drawings as early as required to support the project schedule. Allow for two weeks Engineer review time plus mailing time plus a duplication of this time for resubmittal if required. Submit Shop Drawings as soon as possible before construction starts.
- F. Before submitting Shop Drawings and material lists, the Contractor shall verify that the equipment submitted is mutually compatible and suitable for the intended use. Contractor shall verify that the equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- G. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the shop drawings have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the electronic submittal and shall clearly indicate the materials, performance criteria and accessories being proposed. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- H. The Engineer's checking and subsequent acceptance of such submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless the Contractor has, in writing, called the Engineer's and Architect's attention to such deviations at the time of submission, and secured written acceptance; nor shall it relieve the Contractor from responsibility for errors in dimensions, details, sizes of members, or quantities; or for omissions of components or fittings; or for not coordinating items with actual building conditions and adjacent work.
- I. Product Data: Provide a bill of materials and product cutsheets showing material specifications, electrical characteristics and connection requirements. Highlight or indicate specific product options and accessories as applicable to the project.

J. Shop Drawings:

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Shop drawings shall be prepared by a NICET Level II or higher certified technician. Submit copies of the certification for the designer with submittal.
3. The fire alarm system equipment vendor shall provide shop drawings showing fire alarm floor plans and a full building riser diagram. Fire alarm floor plans and riser diagram shall show fire alarm control panel, annunciator, all fire alarm initiating devices and notification appliances. Show typical wiring diagrams of control panel/s, annunciator and each device and wiring connections required. Show all interfaces to other systems, such as temperature control systems, and security systems.
4. The fire alarm floor plans and riser diagram shall show wiring to all fire alarm devices/appliances, indicating wire sizes and quantities as well as conduit/raceway sizes and locations of end-of-line (EOL) resistors. The fire alarm floor plans and riser diagram shall clearly show the routing of all fire alarm system wiring, including all horizontal routing and vertical routing (in chases).
5. Routing of all fire alarm wiring shall comply with the "Survivability" requirements of NFPA 72.
6. Provide a Sequence of Operations Matrix that explains how the submitted fire alarm system functions.
7. Include voltage drop calculations for notification-appliance circuits.
8. Include battery-size calculations.
9. Shop drawing scale shall match the Engineer's drawings where possible. Scale shall not be less than $3/32" = 1'-0"$.
10. Shop drawings shall be produced using computer-aided design. Hand drawn documents will not be reviewed or approved.

K. Indicate within the submittal all applicable UL listings and all applicable approvals or certifications.

L. Qualification Data: Submit copies of the certification for the Installer.

M. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of products.

1.09 ELECTRONIC DRAWING FILES

- A. In preparation of shop or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall complete and send the form attached at the end of this section along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

- A. Refer to Division 1 and General Conditions for Substitutions.
- B. Materials, products and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten calendar days prior to the date for receipt of Bids. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, cuts, performance and test data and other information necessary for an evaluation. A statement

setting forth changes in other materials, equipment or other Work that incorporation of the substitute would require shall be included. The burden of proof of the merit of the proposed substitute is upon the proposer. The Engineer's decision of approval or disapproval to bid of a proposed substitution shall be final.

- D. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
- E. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE DATA

- A. Refer to Division 1 and General Conditions for Operational and Maintenance Manuals.
- B. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- C. The O&M Manuals shall be provided in labeled 3-ring binder with cover, binding label, tabbed fly sheets and plastic insert folders for Record Drawings. Include the following sections with the appropriate information for each section:
 - 1. Typewritten Index.
 - 2. Qualifications. Provide designer and installer qualification.
 - 3. Bill of Materials. Provide complete nomenclature, model number and vendor information for all parts.
 - 4. Operating Instructions. Complete instructions detailing operation and maintenance of all equipment installed.
 - 5. Product Data: Provide product cutsheets for all equipment utilized and installed.
 - 6. Riser diagram.
 - 7. Device addresses.
 - 8. Record copy of site-specific software.
 - 9. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - a. Equipment tested.
 - b. Frequency of testing of installed components.
 - c. Frequency of inspection of installed components.
 - d. Requirements and recommendations related to results of maintenance.
 - e. Manufacturer's user training manuals.
 - 10. Manufacturer's required maintenance related to system warranty requirements.
 - 11. Abbreviated operating instructions for mounting at fire alarm control unit and each annunciator unit.
 - 12. Guarantee. Copy of all guarantees and warranties issued.
 - 13. Contact list with minimum three service representative phone numbers.

1.12 RECORD DRAWINGS

- A. A set of prints shall be kept on the jobsite during construction for the purpose of noting changes to location of all fire alarm equipment, devices, appliances and circuits as finally installed. During the course of construction, the Contractor shall indicate on these drawings, changes made from the Contract Drawings. Particular attention shall be made to those items which need to be located for servicing.
- B. The record drawings shall show actual locations of initiating devices, notification appliances, and end-of-line devices. Show the approximate location, size and type of all wiring and routing of wiring. Drawings should also include one-line riser diagrams showing all devices.

- C. The Contractor shall sign-off on the Record Drawings as being an accurate representation of the completed installation.
- D. Refer to Division 1 and General Conditions for Record Drawings
- E. At the completion of the project, the Contractor shall obtain at their expense, reproducible copies of the drawings and incorporate changes noted on the jobsite work prints onto these sheets. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", with date. The drawings and associated system calculations shall be delivered to the Architect.

1.13 SPARE PARTS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Provide 10% of the total or a minimum of one (1) manual pull station.
 - 2. Provide 10% of the total or a minimum of two (2) of each type of automatic smoke detector.
 - 3. Provide 5% of the total or a minimum of two (2) of each strobe type and candela rating.
 - 4. Provide 5% of the total or a minimum of two (2) of each horn/speaker type. Combination horn/speaker/strobe units matching the units installed are acceptable.
 - 5. Keys and Tools: One extra set for access to locked or tamper proofed components.

1.14 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products indicated in this section with minimum three years documented experience.
- B. Installer: Company specializing in installing the products indicated in this section with minimum three years documented experience. Shall be bondable and licensed Contractor and employ full-time factory-trained and certified installers and technicians. Installers shall provide with the fire alarm submittal proof of factory training for each installer.
- C. Final checkout and verification: Shall be conducted by a technician certified by the National Institute for Certification in Engineering Technologies (NICET) registered as level 2 or higher in the fire protection technology certification program. Provide certification information with fire alarm submittal.
- D. The equipment manufacturer's service department shall be fully stocked in standard parts and components and engaged in the maintenance of fire alarm systems. On-the-premises service shall be available within 4 hours of notification, 7 days a week, 24 hours a day.

1.15 GUARANTEES AND WARRANTIES

- A. Refer to Division 1 and General Conditions for Guarantees and Warranties.
- B. Furnish service and maintenance of fire alarm system including wiring and raceways for one year from date of substantial completion.
- C. All components, system software, parts and assemblies shall be guaranteed against defects in materials and workmanship for the one-year period stated above, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty.
- D. Labor (including travel expenses) to trouble-shoot, repair, reprogram, or replace components shall be furnished by this contractor at no charge during the warranty period.
- E. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software.

1.16 PROJECT CONDITIONS

- A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:
 - 1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting a bid to determine the nature and extent of work involved.
 - 2. Work in the existing building shall be scheduled with the Owner.

3. Certain demolition work must be performed prior to the remodeling. The Fire Alarm Contractor shall perform the demolition which involves fire alarm system equipment and materials.
 4. Fire Alarm Contractor shall remove articles which are not required for the new work. Unless otherwise indicated, each item removed by the Contractor during this demolition shall be removed from the premises and disposed of in accordance with applicable federal, state and local regulations.
 5. Fire Alarm Contractor shall relocate and reconnect fire alarm equipment that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. General Contractor shall install finish material.
 6. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
 7. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 8. Locate, identify, and protect Fire alarm services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.
- C. 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 fire watch service according to local Fire Department requirements:
1. Notify Architect no fewer than five days in advance of proposed interruption of fire alarm service.
 2. Do not proceed with interruption of fire alarm service without Owner's written permission.
- D. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.17 SEQUENCING AND SCHEDULING

- A. Existing Fire alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As 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 the building.
- B. Equipment Removal: After acceptance of new fire alarm system, remove all unused fire alarm equipment, wiring and installation materials not necessary for system functionality or spare parts.

PART 2 - PRODUCTS AND MATERIALS

2.01 SYSTEM DESCRIPTION

- A. Noncoded, UL-listed addressable system, with multiplexed signal transmission and voice/strobe evacuation.
- B. All components provided shall be listed for use with the selected system.
- C. 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.
- D. Source Limitations for Fire alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested, and will operate, as a system.

2.02 MANUFACTURER

- A. Subject to compliance with requirements, provide products manufactured by the following manufacturers compatible with the existing system.

2.03 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire alarm signal initiation shall be by one or more of the following devices.
1. Manual pull stations.
 2. Smoke detectors.
 3. Automatic sprinkler system water flow.
- B. Fire alarm signal shall initiate the following actions:
1. Identify alarm and specific initiating device at fire alarm control unit and remote annunciators (if provided).
 - a. A pulsing alarm tone shall occur within the control panel until acknowledged.
 - b. The alarm LED shall flash on the control panel and remote annunciator panel until the alarm has been acknowledged at the control panel/remote annunciator panel. Once acknowledged, this same LED shall latch on and the custom label for the address in alarm shall be displayed on the alphanumeric LCD readout. A subsequent alarm received from another address after acknowledged shall flash the alarm LED on the control panel showing the new alarm information.
 2. Transmit an alarm signal to the alarm supervising station.
 3. Audible notification appliances shall sound until silenced by the alarm silence switch at the control panel.
 4. All visible alarm notification appliances shall display a continuous synchronized pattern until reset by the Alarm Reset Switch.
 5. Record events in the system memory.
 6. Unlock electric door locks in designated egress paths.
 7. Release fire and smoke doors held open by magnetic door holders.
 8. Activate voice/alarm communication system.
 9. All fan-powered air-handling equipment shall shutdown and remain down until the fire alarm control panel is reset.
 10. Close smoke dampers in air ducts of designated air-conditioning duct systems.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
 2. Duct-smoke detectors
 3. User disabling of zones or individual devices.
 4. Loss of communication with any panel on the network.
- D. System Supervisory Signal Actions:
1. Identify specific device causing supervisory signal fire alarm control unit and remote annunciators (if provided).
 - a. Visible and audible supervisory alarm indicated by address at fire alarm control panel.
 - b. Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible supervisory alarm; visible alarm is displayed until device is returned to its normal position/supervisory condition is cleared.
 2. Record events in the system memory.
 3. After a time delay of 90 seconds transmit a supervisory signal to the alarm supervising station.
 4. Transmit system status to building management system.
 5. Display system status on graphic annunciator.

6. Duct-mounted smoke detectors shall shutdown their respective unit upon detection of smoke and remain down until manually reset.
7. Individual fan-powered air distribution equipment less than 2,000 cfm that is not provided with duct detection shall shutdown when the respective air handling unit is shutdown.
- E. System trouble signal initiation shall 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 any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 4. Loss of primary power at fire alarm control unit.
 5. Ground or a single break in internal circuits of fire alarm control unit.
 6. Abnormal ac voltage at fire alarm control unit.
 7. Break in standby battery circuitry.
 8. Failure of battery charging.
 9. Abnormal position of any switch at fire alarm control unit or annunciator.
 10. Voice signal amplifier failure.
- F. System Trouble Signal Actions:
 1. Identify specific device causing trouble signal fire alarm control unit and remote annunciators (if provided).
 - a. Visible and audible trouble alarm indicated by address at fire alarm control panel.
 - b. Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible trouble alarm; visible alarm is displayed until device is returned to its normal position/trouble condition is cleared.
 2. Record events in the system memory.
 3. After a time delay of 90 seconds, transmit a trouble signal to the alarm supervising station.
 4. Transmit system status to building management system.
 5. Display system status on graphic annunciator.

2.04 FIRE ALARM SYSTEM CONTROL UNIT

- A. Fire Alarm Panel existing to remain.
 - a.
- B. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 1. Batteries: Sealed lead acid.
 2. The secondary power system shall operate system in standby mode for 24 hours followed by alarm mode for 15 minutes.

2.05 EMERGENCY VOICE/ALARM COMMUNICATIONS SYSTEMS (EVACS):

2.06 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter (DACT) is existing to remain.

2.07 INITIATING DEVICES

- A. Manual Fire Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double action mechanism requiring two actions to initiate an alarm, pull lever type; with integral addressable module arranged to communicate manual station status (normal, alarm, or trouble) to fire alarm control unit.
 2. Station Reset: Key or wrench operated switch.
 3. Indoor Protective Shield: Factory fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
- B. System Smoke Detectors: Photoelectric type complying with UL 268 operating at 24-V dc, nominal with integral addressable module arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control unit.
1. Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base.
 2. Device shall have an integral visual-indicating light, LED type, indicating detector has operated and power-on status.
 3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 4. Photoelectric detectors shall have sensitivity between 0.5 and 3.5 percent/foot smoke obscuration.
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A with a standard, relay or isolator detector mounting base. Provide manufacturer's standard housing to protect the measuring chamber from damage and insects. Provide drilling templates and gaskets to facilitate locating and mounting the housing.
1. Provide for variations in duct air velocity between 100 and 4,000 feet per minute.
 2. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet.
 3. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 4. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor control circuit.
 5. Provide remote alarm LEDs and remote test stations as shown on the plans.
 6. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.

2.08 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
1. Combination Devices: Factory integrated audible and visible devices in a single mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections. Minimum audible level and strobe intensity shall meet all requirements for separate appliances.
 2. Provide strobe synchronization as required per NFPA 72.
 3. Wall mounted notification appliances shall be manufacturer standard and match existing finish.
 4. Ceiling mounted notification appliances shall be manufacturer standard and match existing finish.
- B. Alarm Speakers: Comply with UL 1480. High quality tone and voice reproduction; capacitor connected for connection to supervised notification appliance circuit; semi-flush mounting; four inch cone; high impact, flame retardant PC/ABS thermoplastic; 25 or 70 VRMS; multi-tapped output power rated ¼ to 2 watts and produce 79 to 88 dB at 10 feet.

C. Special Application Speakers (Wall Mount):

1. Atlas/Soundolier voice control loudspeaker, model number APF-15TU. Model shall be a double re-entrant type with 15 watts RMS audible power rating compression driver producing a UL-rated sound pressure level of 102 dB measured at 15 watts at 10 feet, within a frequency range of 400 Hz to 4 kHz. Loudspeaker assembly shall be furnished with mounting bracket allowing adjustment on either a vertical or horizontal plane with a single locking pin and including provisions for mounting, banding or strapping. Wiring terminals for amplifier output shall be fully enclosed and vandal-resistant adapter cover shall provide connection facilities for cable or conduit. Unit shall be finished in red baked epoxy.
2. Wheelock ET 1010 Speaker - vandal resistant loud speaker. Speaker includes both 25 and 70 volt VRMS inputs with field selectable power taps from 1/8 to 8 watts with listed sound output up to 96 dB for speakers. All models shall have provisions for standard NAC supervision and IN/OUT field wiring using terminals that accept #12 to #18 AWG wiring.

D. Visible Alarm Notification Appliances (Strobes): Xenon strobe lights complying with UL 1971, unfiltered or clear filtered white light, with candela ratings as indicated on drawings. Strobes shall meet all requirements of the Americans with Disabilities Act.

2.09 AUXILIARY DEVICES

- A. Magnetic Door Holders: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 3. Rating: 120-V ac.
- B. Waterflow Alarm Switches: Shall be provided by the Fire Sprinkler Installer and shall be wired complete and ready for use by the Fire Alarm System Installer. Switch shall have an adjustable delay to minimize false alarms due to fluctuations in water pressure.
- C. Valve (Tamper) Switches: Shall be provided by the Fire Sprinkler Installer and shall be wired complete and ready for use by the Fire Alarm System Installer.
- D. Monitor Module: Addressable microelectronic module providing a system address for alarm initiating devices for wired applications with normally open contacts. Include address setting means on the module.
- E. Control/Relay Module: Provide intelligent control relay modules. The Control Relay Module shall provide one form "C" dry relay contact rated at 2 amps @ 24 VDC to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware.

2.10 FIRE ALARM WIRE AND CABLE

- A. Fire Alarm Power Branch Circuits: Building wire as specified in Division 26.
- B. Fire alarm Wire and Cable: NRTL listed and labeled as complying with NFPA 70 (NEC) Article 760. All wiring, including wiring to existing modified devices and appliances shall be new.
- C. Signaling Line, Initiating Device and Notification Appliance Circuits: Power limited fire protective signaling cable, solid copper conductor, 300 volts insulation, suitable for temperature, conditions and location installed. Minimum wire size for initiating device circuits, control circuits and notification appliance circuits shall be determined by calculations and manufacturer's requirements or recommendations. Wire and cable shall be twisted and shielded if recommended by the system manufacturer.
- D. The type of cable chosen should be based on fire alarm system requirements, specification requirements and applicable code requirements. Consideration should also be given to the length of cable runs and potential interference.
- E. Initiating, notification, and control circuits shall be sized based on 20% additional power consuming devices.

- F. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems.
- G. 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 2-hour rating.
- H. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket and red identifier stripe, NRTL listed for fire alarm and cable tray installation, plenum rated.
- I. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits: Provide circuitry, which meets the performance requirements during abnormal conditions, based upon the class of the circuitry selected.
 - 1. Initiating Device Circuits: Match existing circuits.
 - a. Pathway Survivability: Match existing circuits .
 - 2. Notification Appliance Circuits: Match existing circuits.
 - b. Pathway Survivability: Match existing circuits
 - 3. Signaling Line Circuits: Match existing circuits.
 - c. Pathway Survivability: Match existing circuits
 - 4. Any circuits interconnecting fire alarm control panels between separate buildings shall be provided with surge protection.

2.11 ACCESS TO EQUIPMENT

- A. All detectors, modules, equipment, etc. shall be located so as to provide easy access for operation, service inspection and maintenance.
- B. Access Doors:
 - 1. Provide access doors for all concealed equipment, except where above lay-in ceilings.
 - 2. Access doors shall be adequately sized for the devices served with a minimum size of 18" x 18", furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
 - 3. Access doors must be of the proper materials for type of construction where installed.
 - 4. The exact location of all access doors shall be verified with the Architect prior to installation.
 - 5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
 - 6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
 - b. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - 7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
 - 8. Locking Devices: Flush, screwdriver-operated cam locks.
 - 9. Locking Devices: Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.
 - 10. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - a. Arrow United Industries.

- b. Bar-Co., Inc.
- c. J.L Industries.
- d. Karp Associates, Inc.
- e. Milcor Div. Inryco, Inc.
- f. Nystrom Building Products
- g. Wade
- h. Zurn

PART 3 - EXECUTION

3.01 GENERAL

- A. The Contractor shall install, program and test all new equipment identified in this contract and revise existing equipment as noted in accordance with the applicable codes, standards, and manufacturer's instructions.
- B. The installation supervisor shall be on the job site during the entire installation. The installation supervisor shall maintain marked up copies of the drawings at the job site showing as-built conditions. These drawings shall be updated daily and available for Owner review.
- C. The Contractor shall provide all required conduit and all associated hardware, and shall install (pull), connect, and test all cable for a complete fire alarm system. All wiring shall be installed in accordance with the guidelines of these specifications and documents as well as the NFPA codes and standards listed in these specifications.

3.02 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.

3.03 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 and requirements of authorities having jurisdiction for installation and testing of fire alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Connecting to Existing Equipment: Verify that existing fire alarm system is operational before making changes or connections.
 - 1. Connect new equipment to existing control panel.
 - 2. Expand, modify, and supplement existing control/monitoring equipment as necessary to extend existing functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
- C. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.

- D. Manual Fire alarm Boxes: Provide manual fire alarm boxes as shown on drawings. Mount manual fire alarm box on a background of a contrasting color. The operable part of manual fire alarm box shall be at 48 inches above floor level unless noted otherwise.
- E. Smoke : Provide detectors as shown on drawings.
 - 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke detector spacing.
 - 2. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
 - 3. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
 - 4. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
 - 5. Install ceiling mounted detectors in areas with exposed structure tight to underside of floor/roof deck unless noted otherwise on drawings.
- F. Duct Smoke Detectors: Comply with NFPA 72. Install sampling tubes so they extend the full width of the duct. Tubes more than 36 inches long shall 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.
 - 2. Provide duct detection and shutdown for fan powered air distribution equipment exceeding 2,000 cfm.
 - 3. Provide equipment and connections to shutdown fan powered air distribution equipment with a capacity less than 2,000 cfm that are part of an air distribution system with a capacity greater than 2,000 cfm.
- G. Single Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- H. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, or valve-tamper switch that is not readily visible from normal viewing position.
- I. Install ceiling mounted visible and audible/visible notification appliances in areas with exposed structure to bottom of floor/roof structure or at 30 ft AFF, whichever is lower.
- J. Install ceiling mounted visible and audible/visible notification appliances in areas with finished ceilings flush with bottom of ceiling or at 30 ft AFF, whichever is lower.
- K. Install wall mounted visible and audible/visible notification appliances with visible element (strobe) between 80 inches and 96 inches above finished floor unless noted otherwise on drawings.
- L. Install wall mounted audible devices with the top of the device at least 90 inches above finished floor or 6 inches below the ceiling, whichever is lower, unless noted otherwise on Drawings. If combination devices are installed, they shall be installed per the visible signal device requirements.
- M. All notification appliance speakers shall be tapped at ½ watt unless noted otherwise on drawings. In rooms less than 100 sq ft, speakers are permitted to be tapped at ¼ watt.
- N. Mount outlet box for electric door holder to withstand 80 pounds (36.4 kg) pulling force.

3.04 PATHWAYS

- A. Pathways above suspended ceilings and in nonaccessible locations may be routed exposed where permitted by NFPA 70 & 72.
 - 1. Exposed pathways located less than 96 inches above the floor shall be installed in conduit.
- B. Pathways shall match existing.

- C. All detection and control circuits associated with smoke control systems shall be fully enclosed within continuous raceways.
- D. Minimum allowable conduit size shall be $\frac{3}{4}$ inch. The conduit shall be sized so that conduit fill does not exceed 75% of NFPA 70 maximum fill requirements. Cables in vertical risers shall not exceed 50% of NFPA 70 maximum fill requirements. Conduit installation shall be as required by the Contractor's layout and as described in these specifications. All conduit field routing shall be acceptable to the Owner. Routing not acceptable shall be rerouted and replaced without expense to the Owner.
- E. All wire, cable, conduit and raceways shall be concealed in walls, ceiling spaces, electrical shafts or closets in finished areas except as specifically noted otherwise. Conduit and raceways may be exposed in unfinished areas or where specifically approved by the Owner.
- F. Except as otherwise specified or indicated on the drawings, all conduit shall be installed parallel or perpendicular to dominant surfaces with right angle turns made of symmetrical bends or fittings. Except where prevented by the location of other work, a single conduit or a conduit group shall be centered on structural members.
- G. Conduit shall be located at least six inches from hot water or steam pipes, and from other hot surfaces. Conduit shall not block access to any existing equipment or fixtures.
- H. Mount end-of-line device in box with last device or separate box adjacent to last device in circuit for conventional hardwired class B initiating and notification appliance circuits.
- I. Conduit shall be securely fastened to all boxes and cabinets. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit. The locknuts both inside and outside shall then be tightened sufficiently to bond the conduit securely to the box. Conduit shall enter cabinets from the bottom and sides only.

3.05 CONNECTIONS

- A. All wiring shall be terminated at devices or panels using terminal connectors for screw type terminals. All terminal connectors for conductors shall be pre-insulated ring type or pre-insulated spade type. Pre-insulated terminal connectors shall include a vinyl sleeve, color coded to indicate conductor size. Pre-insulated terminal connectors shall include a metallic support sleeve bonded to the vinyl-insulating sleeve and designed to grip the conductor insulation.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Alarm initiating connection to smoke control system (smoke management) at firefighters' smoke control system panel.
 - 2. Alarm initiating connection to stairwell and/or elevator shaft pressurization systems.
 - 3. Smoke dampers in air ducts of designated HVAC systems.
 - 4. Provide equipment and connections to shutdown fan powered air distribution equipment with an individual capacity less than or equal to 2,000 cfm that are part of an air distribution system with a design capacity greater than 2,000 cfm.
 - 5. Magnetically held-open doors.
 - 6. Electronically locked doors and access gates.
 - 7. Alarm initiating connection to elevator recall system and components.
 - 8. Alarm initiating connection to activate emergency lighting control.
 - 9. Connection to disable sound systems upon alarm activation.
 - 10. Supervisory connections at valve supervisory switches.
 - 11. Supervisory connections at low-air pressure switch of each dry-pipe sprinkler system.
 - 12. Supervisory connections at elevator shunt-trip breaker.

13. Data communication circuits for connection to building management system.
14. Supervisory connections at fire pump power failure including a dead-phase or phase-reversal condition.
15. Supervisory connections at fire pump engine control panel.

3.06 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

3.07 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. All conduits and junction boxes shall be labeled as specified in Division 26 (red).
- C. The location of end-of-line resistors shall be identified with a label indicating "EOL."
- D. Provide label at each initiating device indicating the device address. Label shall be visible from the floor below or immediately adjacent to the device.

3.08 GROUNDING

- A. Ground fire alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.09 FIELD QUALITY CONTROL

- A. Systems shall be checked and tested in accordance with the instructions provided by the manufacturer to insure that the system functions as required and is free of grounds, opens, and shorts. Each device shall be tested.
 1. Smoke detectors shall be tested with products of combustion.
- B. Upon completion of the system installation and before the Date of Final Acceptance, a factory-trained technician shall perform all necessary tests and adjustments and shall then file a Letter of Certification and a Certificate of Completion (NFPA 72) with the Owner indicating that the system functions and conforms to the Fire Alarm System Specifications.
- C. Upon completion of the system installation, a factory-trained technician shall perform all necessary tests and adjustments in the presence of the Owner's designated personnel. Test in accordance with NFPA 72 and requirements of the authority having jurisdiction. Perform the following tests at a minimum:
 1. Visual Inspection: Conduct visual inspection prior to testing. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - a. Test audible appliances for the public operating mode according to manufacturer's written instructions.
 - b. Test visible appliances for the public operating mode according to manufacturer's written instructions.
- D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- E. Fire alarm system will be considered defective if it does not pass tests and inspections.
- F. Include services of factory trained and certified technician to supervise installation, adjustments, final connections, and system testing as performed by the fire alarm contractor's factory-trained technicians.

3.10 DEMONSTRATION

- A. The equipment supplier's factory trained technician shall train the Owner's personnel in the proper use and maintenance of the system. Training sessions shall be conducted as needed, not to exceed a total of 2 sessions, with each session lasting a maximum of 4 hours each.
- B. Demonstrate normal and abnormal modes of operation, and required responses to each.
- C. Video tape the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

END OF SECTION 284600

Project Manual



LEE'S SUMMIT
MEDICAL CENTER

Lee's Summit Medical Center ICU Expansion

2100 SE Blue Parkway
Lee's Summit, Missouri

Volume 2 of 2 (Divisions 15 thru 32)

January 14, 2022

ACIB Project #3-21112



TABLE OF CONTENTS

DIVISION 21 - FIRE SUPPRESSION SPECIFICATION

210010	GENERAL FIRE SUPPRESSION REQUIREMENTS
210500	COMMON WORK RESULTS FOR FIRE SUPPRESSION
210515	BASIC FIRE SUPPRESSION PIPING METHODS AND MATERIALS
210548	SEISMIC CONTROLS FOR FIRE SUPPRESSION
211313	WATER BASED FIRE SUPPRESSION SYSTEMS

DIVISION 22 - PLUMBING SPECIFICATION

220010	GENERAL PLUMBING REQUIREMENTS
220015	COORDINATION
220500	COMMON WORK RESULTS FOR PLUMBING
220515	BASIC PIPING MATERIALS AND METHODS
220516	EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING
220523	GENERAL-DUTY VALVES FOR PLUMBING PIPING
220529	HANGERS AND SUPPORTS FOR PLUMBING PIPING
220553	IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT
220700	PLUMBING INSULATION
221100	WATER DISTRIBUTION PIPING & SPECIALTIES
221300	SANITARY DRAINAGE & VENT PIPING & SPECIALTIES
221400	STORM DRAINAGE PIPING & SPECIALTIES
224000	PLUMBING FIXTURES
226100	GAS & VACUUM SYSTEMS FOR HEALTH CARE FACILITIES

DIVISION 23 - HEATING, VENTILATING, AND AIR-CONDITIONING SPECIFICATION

230010	GENERAL MECHANICAL REQUIREMENTS
230519	METERS AND GAUGES FOR HVAC PIPING
230523	GENERAL DUTY VALVES FOR HVAC PIPING
230529	SUPPORTS, ANCHORS AND ISOLATORS
230553	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
230593	TESTING, ADJUSTING, AND BALANCING FOR HVAC
230700	HVAC INSULATION
230800	COMMISSIONING OF HVAC SYSTEMS

230800	COMMISSIONING OF HVAC SYSTEMS
230913	INSTRUMENTATION AND CONTROL DEVICE FOR HVAC
230923	DIRECT DIGITAL CONTROL SYSTEM
232113	HYDRONIC PIPING
232116	HYDRONIC SPECIALTIES
232216	STEAM AND CONDENSATE PIPING SPECIALTIES
233113	METAL DUCTS
233300	AIR DUCT ACCESSORIES
233423	HVAC POWER VENTILATORS
233600	AIR TERMINAL UNITS
233713	DIFFUSERS REGISTERS AND GRILLES
237413	OUTDOOR CENTRAL STATION AIR HANDLING UNITS
238413	HUMIDIFIERS (DISPERSION TYPE)

DIVISION 26 - ELECTRICAL SPECIFICATION

260010	GENERAL ELECTRICAL REQUIREMENTS
260015	ELECTRICAL MATERIALS PURCHASING
260500	COMMON WORK RESULTS FOR ELECTRICAL
260502	EQUIPMENT WIRING SYSTEMS
260519	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
260529	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
260533	RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS
260543	UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS
260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS
260573	OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY
260923	LIGHTING CONTROL DEVICES
262200	LOW-VOLTAGE TRANSFORMERS
262416	PANELBOARDS
262726	WIRING DEVICES
262813	FUSES
264313	SUREGE PROTECTIVE DEVICE
265100	INTERIOR LIGHTING
265600	EXTERIOR LIGHTING

DIVISION 28 - ELECTRONIC SAFETY & SECURITY SPECIFICATION

284600	FIRE DETECTION AND ALARM
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SECTION 21 00 10 GENERAL FIRE SUPPRESSION REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.01 DESCRIPTION OF WORK

- A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.
- B. Division 21 of the Specifications and Drawings numbered with prefixes FX generally describe these systems, but the scope of the Fire Suppression work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Fire Suppression, Mechanical, Plumbing, Fire Alarm and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general location and arrangement of the equipment, piping, etc. without showing all the exact details as to elevations, offsets, pipe routing, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.
 - 2. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.
 - 3. Division 21 Section 210515 "Basic Fire Suppression Piping Material and Methods," for general piping and fitting materials and methods.
 - 4. Division 21 Section 210548 "Seismic Controls for Fire Protection" for seismic bracing requirements.
 - 5. Division 21 Section 211313 "Water-based Fire Suppression Systems" for fire suppression sprinkler systems inside the building.

1.02 QUALITY ASSURANCE

- A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturer's requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.
- D. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- E. 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.

- F. Threaded joints shall conform to ASME B1.20.1, Pipe Threads, General Purpose and the Pipe Fitters Handbook.
- G. Regulatory Requirements: Comply with all standards listed in Section 1.2 and all applicable local requirements.
- H. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section, Division 26 and Division 28.
- I. Through and Membrane Penetration Firestopping Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

1.03 CODES, REFERENCES AND STANDARDS

- A. Execute Work in accordance with the National Fire Protection Association Standards and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.
- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the submission of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.
- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.
- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes.
 - 1. NFPA (National Fire Protection Association) 13, "Installation of Sprinkler Systems", 2010 Edition.
 - 2. NFPA 25, "Inspection, Testing and Maintenance of Water-Based Fire Protection Systems", 2011 Edition.
 - 3. Underwriters Laboratories, "Fire Protection Equipment Directory", Latest Edition.
 - 4. HCA Healthcare Design and Engineering Guidelines for Hospitals, 2021 Edition
- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. All Fire Suppression work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the Fire Suppression work shall be provided by the Contractor.

1.04 DEFINITIONS

- A. General:
 - 1. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."
 - 2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
 - 3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use." When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

4. **Furnished by Owner or Furnished by Others:** The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
5. **Engineer:** Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
6. **AHJ:** The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
7. **NRTL:** Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
8. **Substitution:** Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
 - a. **Substitutions for Cause:** Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - b. **Substitutions for Convenience:** Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
9. **Value Engineering:** A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
- C. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).
- D. Other definitions for fire protection systems are listed in NFPA Standards 13 and 24.
- E. Working Plans, also referred to as Fire Protection Drawings as used in this Section means those documents (including drawings and calculations) prepared pursuant to the requirements contained in NFPA 13 for obtaining approval of the Authority Having Jurisdiction.
- F. The following definitions apply to excavation operations:
 1. **Additional Excavation:** Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
 2. **Sub-base:** as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
 3. **Subgrade:** as used in this Section refers to the compacted soil immediately below the slab or pavement system.

4. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

1.05 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.
- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping in the manner anticipated in the design.
- C. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the Fire Suppression systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the work in such a manner that the work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.
- D. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect/Engineer. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.
- E. The contractor shall coordinate work in this section with all related trades. Work and/or equipment provided in other sections and related to the fire protection system shall include, but not be limited to:
 1. Sprinkler monitoring equipment (water flow switches, valve tampers, etc) shall be provided by the fire sprinkler installer, but wired and connected by Division 28.
- F. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and described within the specification sections.

1.06 MEASUREMENTS AND LAYOUTS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.07 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.
 1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
 2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
 3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.

4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
 6. Indicate required installation sequence to minimize conflicts between entities.
 7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.
- B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.
1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
 2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.
 3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.
 4. Include work provided by others routed through the equipment rooms.
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.
 - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.
 3. Where Henderson Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, Henderson Engineers makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.
 4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

1.08 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements, in addition to requirements specified herein.
- B. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- C. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings,

manufacturer product data, performance sheets, samples, and other submittals required by this Division. Provide the number of submittals required by Division 1; if hard-copy sets are provided, submit a minimum of seven (7) sets. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

- D. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- E. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- F. Refer to individual Sections for additional submittal requirements.
- G. Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time, plus to/from mailing time via the Architect, plus a duplication of this time for resubmittals, if required. Transmit submittals as soon as possible after Notice to Proceed and before Fire Suppression construction starts.
- H. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- I. Submittals shall contain the following information:
 - 1. The project name.
 - 2. The applicable specification section and paragraph.
 - 3. Equipment identification acronym as used on the drawings.
 - 4. The submittal date.
 - 5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
 - 6. Submittals not so identified will be returned to the Contractor without action.
- J. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow for the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.
- K. The checking and subsequent acceptance by the Engineer and/or Architect of submittals shall not relieve responsibility from the Contractor for (1) deviations from the Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Architect prior to implementing any deviation.
- L. Provide shop drawings prepared in accordance with referenced standards identified as "Working Plans", including hydraulic calculations where applicable. Shop drawings shall be signed and sealed by a Professional Engineer registered in the state in which the project is located where required by local authorities having jurisdiction, or NICET Level III or IV certified technician. Submit copies of the certification for the designer with submittal. Shop drawings consisting of the following shall be furnished at a minimum. Refer to NFPA 13 for additional requirements.

1. Scaled site plan indicating underground piping with sizes and hydrants utilized for flow test in relation to the building.
 2. Layout drawings of complete fire sprinkler system indicating relationship to all other trades. This shall include all equipment, piping and a reflected ceiling plan indicating sprinkler locations.
 3. Complete details and sections as required to clearly define and clarify the design indicated.
 4. Shop drawings shall be to a standard scale and not less than 3/32" = 1'-0".
 5. Shop drawings shall be produced using computer-aided design. Hand drawn documents will not be reviewed or approved.
 6. Hydraulic calculations shall be based on a water flow test conducted at the site within twelve (12) months of the submittal of plans for approval. The contractor shall be responsible for obtaining the flow test if existing data is not available. Flow test information shall be documented on shop drawings with an accompanying site plan to scale. Contractor shall verify with AHJ any minimum safety factor requirements. Demand shall not be less than 10 percent below the supply at the demand point.
 - a. Hydrant testing shall be in accordance with NFPA 13 and 291 requirements.
- M. Contractor shall prepare installation drawings (working shop drawings) based upon this design. Requests for deviations from the approved design shall be submitted in writing to the Engineer of Record for approval. Shop drawings showing deviations from the design without prior approval will not be approved.
- N. Provide welders' qualification certificates.
- O. Provide Test Reports and Certificates including:
1. "Contractor's Material & Test Certificate for Aboveground Piping"
- P. Contractor to submit engineer approved sprinkler shop drawings to HCA's insuring agency, AIG, for review. Email plans to planreview.americas@aig.com and copy james.dipaoli@aig.com. Anthony's alternate contact information is:
- Jamie DiPaoli, PE
99 High Street, 24h Floor, Boston MA 02110
Tel +1 617 457 5847 | Cell +1 862 245 3572

1.09 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

- A. Refer to Division 1 and General Conditions for substitutions in addition to requirements specified herein.
- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
2. The burden of proof of the merit of the proposed substitution is upon the proposer.
3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
 - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
 - c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
 - d. Same warranty will be furnished for proposed substitution as for specified Work.
 - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
 - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.
- E. Substitution Consideration:
 1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
 2. No substitutions will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.
 3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
 4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion for the project, furnish to the Architect, for Engineer's review, and for Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- E. Include the following sections with the appropriate information for each section:
 1. Typewritten Index.
 2. Qualifications. Provide designer and installer qualification.
 3. Bill of Materials. Provide complete nomenclature, model number and vendor information for all parts.
 4. Operating Instructions. Complete instructions detailing operation and maintenance of all equipment installed.

5. Product Data: Provide product cut-sheets for all equipment utilized and installed.
 6. Guarantee. Copy of all guarantees and warranties issued.
 7. Testing/Certification: Provide all completed testing and certification forms as required per NFPA 13 and 25.
 8. Contact list with minimum three service representative phone numbers.
- F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives.

1.12 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections in Division 21 specifications.

1.13 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.
- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.
- D. The fire shop drawings and all information contained therein shall be utilized as the basis for the Record Drawings.

1.14 TRAINING

- A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video tape the training sessions in a format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.15 PAINTING

- A. Exposed ferrous surfaces, including pipe, pipe hangers, equipment stands and supports shall be painted by the Fire Suppression Contractor using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.
- B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.
- C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.16 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 1 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.
- D. The Contractor shall be responsible for the safe storage of his own tools, material and equipment.

1.17 GUARANTEES AND WARRANTIES

- A. Refer to Division 1 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.
- B. Furnish service and maintenance of fire protection system for one year from date of substantial completion.
- C. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.
- D. The following additional items shall be guaranteed:
 - 1. Piping shall be free from obstructions, holes or breaks of any nature.
 - 2. Proper sloping of pipe to drain in each piping system per NFPA 13.
- E. The above guarantees shall include labor (including travel expenses), troubleshooting and material; and repairs or replacements shall be made without additional cost to the Owner.
- F. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.
- G. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed and stating the commencement date and term.

1.18 PROJECT CONDITIONS

- A. Conditions Affecting Work In Existing Buildings:
 - 1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the site prior to submitting their bid to determine the nature and extent of work involved.
 - 2. Work in the existing building shall be scheduled with the Owner.
 - 3. Certain demolition work must be performed prior to the remodeling. The Fire Suppression Contractor shall perform the demolition which involves Fire Suppression and Fire Suppression systems, equipment, piping, equipment supports or foundations and materials.
 - 4. Fire Suppression Contractor shall remove articles which are not required for the new work. Unless otherwise indicated, each item removed by the Fire Suppression Contractor during this demolition shall be removed by the Fire Suppression Contractor from the premises and disposed of in accordance with applicable federal, state and local regulations.
 - 5. Fire Suppression Contractor shall relocate and reconnect Fire Suppression equipment that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Fire Suppression equipment or materials are removed, the Fire Suppression Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.
 - 6. General Contractor shall install finish material.

7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
 8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 9. Locate, identify, and protect Fire Suppression services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Conditions Affecting Excavations: The following project conditions apply:
1. Maintain and protect existing building services which transit the area affected by selective demolition.
 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
 3. Use of explosives is not permitted.
- C. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

2.01 GENERAL

- A. Electrical Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Fire Suppression Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, the Fire Suppression Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.
- B. Refer to Division 26, "Common Work Results for Electrical" for specification of motor connections.
- C. Refer to Division 26, "Enclosed Switches and Circuit Breakers" for specification of disconnect switches.
- D. Refer to Division 28, "Fire Detection and Alarm" for specification of sprinkler monitoring equipment connections.
- E. All fire protection equipment shall be UL listed for its intended use and in conformance with the applicable NFPA codes.
- F. System Pressures: All system components shall be listed for the actual designed system pressures.
1. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

PART 3 - EXECUTION

3.01 GENERAL

- A. The Contractor shall install, and test all new equipment identified in this contract and revise existing equipment as noted.
- B. Installation shall be in accordance with NFPA requirements and the Contractor shall have employed or enlist the design services of at least one minimum NICET Level II certified technician.

- C. Installer: Company specializing in the products indicated in this section with minimum three years documented experience. Shall be bondable and licensed contractor and employ full-time factory-trained and certified installers and technicians. Installers shall provide with the fire sprinkler submittal proof of factory training for each installer.
- D. The Contractor shall provide all required equipment, sprinklers and piping for a complete and operational fire protection system. All components shall be installed in accordance with the guidelines of these specifications and documents as well as the NFPA codes and standards listed in these specifications.
- E. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

3.02 PERMITS

- A. Secure and pay for permits required in connection with the installation of the Fire Suppression Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.03 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Section.
- B. Report test results promptly and in writing.

3.04 EXISTING UTILITIES

- A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.
- B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.
- C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.
- D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.
- E. Contractor shall include in his bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.05 SELECTIVE DEMOLITION

- A. General: Demolish, remove, demount, and disconnect abandoned Fire Suppression materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- B. Materials and equipment to be salvaged: Remove, demount, and disconnect existing Fire Suppression materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- C. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- D. Fire Suppression Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete piping, fittings, specialties, equipment and controls.
 - a. Piping embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping allowed to remain.
 - b. Perform cutting and patching required for demolition in accordance with Division 1, General Conditions and "Cutting and Patching" portion of this Section in Division 21.

3.06 CUTTING AND PATCHING

- A. The Contractor shall do necessary cutting of walls, floors, ceilings and roofs.
- B. No structural member shall be cut without permission from Architect and Structural Engineer.
- C. Patch around openings to match adjacent construction.
- D. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

3.07 CLEANING

- A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Fire Suppression Contractor shall cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to the final inspection, the Fire Suppression Contractor shall clean material and equipment installed under the Fire Suppression Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.08 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:
 - 1. Submit complete Operation and Maintenance Manuals.
 - 2. Submit complete Record Drawings.
 - 3. Perform special inspections.
 - 4. Start-up testing of systems.
 - 5. Removal of temporary facilities from the site.
 - 6. Comply with requirements for Substantial Completion in the "General Conditions".
- B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.
- C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, they shall reimburse the Architect/Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. He shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 21 00 10

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

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

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Architect: _____

Address: _____ Owner: _____

Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company
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Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company
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Engineer Review and Recommendation Section

Recommend Acceptance ☐ Yes ☐ No
Additional Comments: ☐ Attached ☐ None

Acceptance Section:

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company

SECTION 21 05 00 COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes limited scope general construction materials and methods for application with Fire Suppression installations as follows:
 - 1. Access panels and doors in walls, ceilings, and floors for access to Fire Suppression materials and equipment.
 - 2. Miscellaneous metals for support of Fire Suppression materials and equipment.
 - 3. Wood grounds, nailers, blocking, fasteners, and anchorage for support of Fire Suppression materials and equipment.
 - 4. Joint sealers for sealing around Fire Suppression materials and equipment.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.
 - 2. Division 21 Section 210010 "General Fire Suppression Requirements" for requirements for hydraulic calculations, obtaining electronic drawings files, shop drawings and record drawings.
 - 3. Division 21 Section 210515 "Basic Fire Suppression Piping Material and Methods," for general piping and fitting materials and methods.
 - 4. Division 21 Section 210548 "Seismic Controls for Fire Protection" for seismic bracing requirements.
 - 5. Division 21 Section 211313 "Water-based Fire Suppression Systems" for fire suppression sprinkler systems inside the building.

1.02 SUBMITTALS

- A. General: Submit the following in accordance with Division 1 and Division 21 Section "General Fire Suppression Requirements".
 - 1. Product data for the following products:
 - a. Access panels and doors.
 - b. Through and membrane-penetration firestopping systems.
 - 2. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
 - a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 1 Section "Summary of Work."

1.03 QUALITY ASSURANCE

- A. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
 - 1. Provide UL Label on each fire-rated access door.

PART 2 - PRODUCTS AND MATERIALS

2.01 ACCESS TO EQUIPMENT

- A. Acceptable Manufacturers:

1. Bar-Co., Inc.
2. Elmdor Stoneman.
3. JL Industries
4. Jay R. Smith Mfg. Co.
5. Karp Associates, Inc.
6. Milcor
7. Nystrom Building Products
8. Wade
9. Zurn

B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section "Identification for Fire Suppression Piping and Equipment" for labeling of access doors.
2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
3. Access doors must be of the proper construction for type of construction where installed.
4. The exact location of all access doors shall be verified with the Architect prior to installation.
5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
 - b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
8. Locking Devices: Flush, screwdriver-operated cam locks.
9. Locking Devices: Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

2.02 FIRE SUPPRESSION EQUIPMENT NAMEPLATE DATA

- A. For each piece of power operated Fire Suppression equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

2.03 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.

- E. Fasteners: Zinc-coated, type, grade, and class as required.

2.04 MISCELLANEOUS LUMBER

- A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPB rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.
1. Framing materials shall be fire resistant treated for use in Type I and II buildings.
- B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches.
1. Framing materials shall be fire resistant treated for use in Type I and II buildings.

2.05 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Architect from manufacturer's standard colors.
- C. Elastomeric Joint Sealers: Provide the following types:
1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:
 - a. "Dow Corning 790," Dow Corning Corp.
 - b. "Silglaze II SCS 2801," General Electric Co.
 - c. "Silpruf SCS 2000," General Electric Co.
 - d. "864," Pecora Corp.
 - e. "Rhodia 5C," Rhone-Poulenc, Inc.
 - f. "Spectrem 1," Tremco, Inc.
 - g. "Spectrem 2," Tremco, Inc.
 - h. "Dow Corning 795," Dow Corning Corp.
 - i. "Rhodia 7B," Rhone-Poulenc, Inc.
 - j. "Rhodia 7S," Rhone-Poulenc, Inc.
 - k. "OmniSeal," Sonneborn Building Products Div.
 2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:
 - a. "Dow Corning 786," Dow Corning Corp.
 - b. "Sanitary 1700," General Electric Co.
 - c. "898 Silicone Sanitary Sealant," Pecora Corp.
 - d. "OmniPlus," Sonneborn Building Products Div.
- D. Acrylic-Emulsion Sealants: One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Chem-Calk 600," Bostik Construction Products Div.
 - b. "AC-20," Pecora Corp.
 - c. "Sonolac," Sonneborn Building Products Div.
 - d. "Tremflex 834," Tremco, Inc.

2.06 ACOUSTICAL SEALANTS

- A. General: Penetrations by pipes through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.
- B. Foam Rod: Foam backer rod shall be closed cell polyethylene suitable for use as a backing for non-hardening sealant.
- C. Non-Hardening Sealant: Sealant for penetrations shall be non-hardening polysulphide type. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.
- D. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 pcf (40 kg/m³).

PART 3 - EXECUTION

3.01 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

3.02 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor Fire Suppression materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.03 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor Fire Suppression materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.04 PREPARATION FOR JOINT SEALERS

- A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.05 APPLICATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - 2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
- B. Tooling: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.06 PENETRATIONS:

- A. New Construction:

1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support piping penetrations.
- B. Construction in Existing Facilities:
 1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.
- C. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.
- D. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.
- E. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.
- F. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.
- G. Cut sleeves to length for mounting flush with both surfaces of walls.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- I. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.
- J. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 21 Section "Basic Fire Suppression Piping Materials and Methods

END OF SECTION 21 05 00

SECTION 21 05 15

BASIC FIRE SUPPRESSION PIPING MATERIALS AND METHODS

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section specifies piping materials and installation methods common to more than one Section of Division 21 and includes piping, joining materials, piping specialties and basic piping installation instructions.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 21 Section 210010 "General Fire Suppression Requirements" for requirements for hydraulic calculations, obtaining electronic drawings files, shop drawings and record drawings.
 - 2. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.
 - 3. Division 21 Section 210548 "Seismic Controls for Fire Protection" for seismic bracing requirements.
 - 4. Division 21 Section 210553 "Identification for Fire Suppression Piping and Equipment" for labeling and identification of installed fire suppression equipment.
 - 5. Division 21 Section 211313 "Water-based Fire Suppression Systems" for fire-suppression sprinkler systems inside the building.

1.02 SUBMITTALS

- A. Refer to Division 1 and Division 21 "General Fire Suppression Requirements" for administrative and procedural requirements for submittals.
- B. Contractor to submit engineer approved sprinkler shop drawings to HCA's insuring agency, AIG, for review. Email plans to planreview.americas@aig.com and copy james.dipaoli@aig.com. Anthony's alternate contact information is:
 - Jamie DiPaoli, PE
 - 99 High Street, 24h Floor, Boston MA 02110
 - Tel +1 617 457 5847 | Cell +1 862 245 3572
- C. Product Data: Submit product data on the following items:
 - 1. Piping and Fittings
 - 2. Escutcheons
 - 3. Dielectric Unions and Fittings
 - 4. Sleeves and Mechanical Sleeve Seals
 - 5. Wall Pipes

1.03 QUALITY ASSURANCE

- A. Welding procedures and testing shall comply with ANSI Standard B31.9 - Standard Code for Building Services Piping and The American Welding Society, Welding Handbook.
- B. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Plumbing Refrigeration.
- C. Threaded joints shall conform to ASME B1.20.1, Pipe Threads, General Purpose and the Pipe Fitters Handbook.
- D. UL Compliance: Fire protection system materials and components shall be Underwriter's Laboratories listed and labeled, and Factory Mutual approved for fire service.
- E. Pipe, piping specialties and fittings shall be manufactured in plants located in the United States.

PART 2 - PRODUCTS AND MATERIALS

2.01 GENERAL REQUIREMENTS

- A. All fire suppression system materials and components essential to successful system operation shall be listed for their intended purpose.
- B. General: Refer to the individual piping system specification sections in Division 21 for specifications on piping and fittings relative to that particular system.

2.02 STEEL PIPE AND FITTINGS

- A. All piping 2-inch and smaller:
 - 1. With the use of threaded fittings: ASTM A135 or 795, Grade A, Schedule 40, seamless or ERW, black steel pipe. All 1-inch piping shall have threaded ends.
 - 2.
- B. All piping 2-1/2" and larger: ASTM A135 or 795, Grade A, Schedule 10, ERW, black steel pipe, roll grooved ends.
- C. Acceptable alternatives to Schedule 40 and Schedule 10 pipe shall be manufactured to standards recognized by HCA Standards. Threaded pipe shall have a corrosion resistance rating (CRR) of 1.0 or greater. Crimp type couplings shall not be used. Victaulic's 'Press-fit' sprinkler piping or threadable thinwall pipe not permitted.
- D. Cast-Iron Threaded Fittings: ANSI B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.
- E. Black Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- F. Steel Couplings: ASTM A 865, threaded
- G. Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- H. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.
- I. Malleable- or Ductile-Iron Unions: UL 860.
- J. Cast-Iron Flanges: ASME 16.1, Class 125.
- K. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- L. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- M. Grooved-Joint, Steel-Pipe Appurtenances
 - 1. Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 - 2. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
 - 3. Grooved mechanical couplings including gaskets used on dry-pipe systems shall be listed for dry-pipe service.

2.03 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.04 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 - 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- E. Plastic, Pipe-Flange Gasket, and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.05 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved.
 - 2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.
- B. Check Valves:
 - 1. Description: Swing-check type, rubber-face checks unless otherwise indicated, and ends matching piping.
 - 2. Standard: UL 312.
 - 3. Pressure Rating: 250 psig minimum.
 - 4. Type: Swing check.
 - 5. Body Material: Cast iron.
 - 6. End Connections: Flanged or grooved.
- C. Bronze OS&Y Gate Valves:
 - 1. Description: Bronze body and bonnet and bronze stem.
 - 2. Standard: UL 262.
 - 3. Pressure Rating: 175 psig.
 - 4. Body Material: Bronze.
 - 5. End Connections: Threaded or grooved.
- D. Iron OS&Y Gate Valves:
 - 1. Description: Iron body and bonnet and bronze seating material.
 - 2. Standard: UL 262.
 - 3. Pressure Rating: 250 psig minimum.
 - 4. Body Material: Cast or ductile iron.
 - 5. End Connections: Flanged or grooved.
- E. Indicating-Type Butterfly Valves:
 - 1. Standard: UL 1091.
 - 2. Pressure Rating: 175 psig minimum.
 - 3. Valves NPS 2 and Smaller:
 - a. Valve Type: Ball or butterfly.
 - b. Body Material: Bronze.
 - c. End Connections: Threaded or grooved.
 - 4. Valves NPS 2-1/2 and Larger:

- a. Valve Type: Butterfly.
- b. Body Material: Cast or ductile iron.
- c. End Connections: Flanged or grooved.
- 5. Valve Operation: Integral, prewired supervisory switch and visual indicating device.

2.06 TRIM AND DRAIN VALVES

- A. General Requirements:
 - 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing (FM insureds only).
 - 2. Pressure Rating: 175 psig minimum.
- B. Automatic (Ball Drip) Drain Valves:
 - 1. Standard: UL 1726.
 - 2. Pressure Rating: 175 psig minimum.
 - 3. Type: Automatic draining, ball check.
 - 4. Size: NPS 3/4.
 - 5. End Connections: Threaded.

2.07 AUTOMATIC AIR RELEASE VALVE

- A. Standard: UL 2573
- B. Pressure Rating: 175 psig minimum.

2.08 FIRE-DEPARTMENT CONNECTIONS

2.09 EXISTING TO REMAIN. PIPING SPECIALTIES

- A. Escutcheons: Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.
 - 1. One-Piece, Cast-Brass Type: With finish that matches existing and setscrew fastener.
 - 2. One-Piece, Stamped-Steel Type: With finish that matches existing and spring-clip fasteners.
 - 3. Split-Casting Brass Type: With finish that matches existing and with concealed hinge and setscrew.
 - 4. Split-Plate, Stamped-Steel Type: With finish that matches existing, concealed hinge, and spring-clip fasteners.
- B. Floor Plates: Inside diameter shall closely fit pipe outside diameter. Outside diameter shall completely cover the opening in floors, walls, or ceilings.
 - 1. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
 - 2. Split-Casting Floor Plates: Cast brass with concealed hinge.
- C. Unions: Malleable-iron, Class 150 for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
- D. Dielectric Unions and Fittings: Provide factory-fabricated dielectric unions and fittings with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.
- E. Pressure Gauges
 - 1. Standard: UL 393.
 - 2. Dial Size: 3-1/2- to 4-1/2-inch diameter.
 - 3. Pressure Gage Range: 0 to 300 psig.
 - 4. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

2.10 PENETRATIONS

A. Sleeves:

1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.
2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.
3. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.
4. Box Frames: Frames for rectangular openings shall be of welded 12 gauge steel attached to forms and of a maximum dimension established by the Architect. Contractor shall notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

B. Wall Pipes

1. Cast-iron sleeve with integral clamping flange with clamping ring, bolts, and nuts for membrane flashing.
 - a. Underdeck Clamp: Clamping ring with setscrews.

C. Mechanical Sleeve Seals: Modular Plumbing type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - a. Pressure Plates: Carbon steel or stainless steel.
 - b. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, or Stainless steel of length required to secure pressure plates to sealing elements.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.02 PIPING INSTALLATIONS

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
- B. Coordinate installation of horizontal piping with other components. Allow sufficient space above removable ceiling panels to allow for panel removal (minimum 6" clearance).
- C. Install system such that all piping is rigidly secured and supported. All ductwork, lights, structural members and main runs of piping shall take precedence over sprinkler piping. Cutting of structural members for passage of sprinkler pipes or hangers shall not be permitted. All

horizontal piping in ceiling space shall be at an elevation above the top of light fixtures and air outlets to allow for access to light fixtures and air outlets without removing horizontal piping. Route all sprinkler piping and provide all offsets, bends, and elbows around all mechanical, electrical, and structural members as required.

- D. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise. In areas with ceilings, piping shall be routed concealed, above ceiling. In areas without ceilings, piping shall extend as high as possible.
- E. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.
- F. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.
- G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- H. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.
- I. Install sprinkler piping to provide for system drainage in accordance with NFPA 13. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple and cap.
- J. Coordinate pipe routing near electrical equipment in accordance with NFPA 70.
- K. Verify final equipment locations for roughing in.
- L. Deviations from approved "Working Plans" for sprinkler piping require written approval of the Authority Having Jurisdiction. Written approval shall be on file with the Engineer prior to deviating from the approved "Working Plans."
- M. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors.

3.03 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Use approved fittings to make all changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- C. Install unions in pipes NPS 2 and smaller, adjacent to each valve. Unions are not required on flanged devices or in piping installations using grooved mechanical couplings.
- D. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- E. Install dielectric unions to connect piping materials of dissimilar metals in dry piping systems.
- F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - a. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- G. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads and Pipe Fitter's Handbook. Join pipe, fittings, and valves as follows:
 - 1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - 2. Align threads at point of assembly.
 - 3. Apply appropriate tape or thread compound to the external pipe threads.
 - 4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.

5. **Damaged Threads:** Do not use pipe with threads that are corroded, or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- H. **Flanged Joints:** Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9. Align flanged surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.
- I. **Mechanical Grooved Joints:** Roll grooves on pipe ends dimensionally compatible with the couplings. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- J. **Joints for other piping materials** are specified within the respective piping system sections.

3.04 ALARM DEVICE INSTALLATION

- A. **General:** Comply with NFPA 24 for devices and methods of valve supervision.
- B. **Supervisory Switches:** Supervise valves in open position unless noted otherwise.
 1. **Valves:** Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
 2. **Indicator Posts:** Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
- C. **Water-Flow Indicators:** Install in fire suppression piping where indicated. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.
- D. **Connect alarm devices** to building's fire-alarm system. Wiring and fire-alarm devices are specified in Division 28 Sections.

3.05 PIPING PROTECTION

- A. **Protect piping** during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. **Place plugs** in ends of uncompleted piping at the end of each day or whenever work stops.

3.06 PENETRATIONS

- A. **Fire suppression penetrations** occur when piping penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies.
- B. **Above Grade Concrete or Masonry Penetrations**
 1. **Provide sleeves** for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:
 - a. **Provide schedule 40 galvanized steel pipe** for sleeves smaller than 6 inches in diameter.
 - b. **Provide galvanized sheet metal** for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).
 - c. **Provide welded galvanized sheet metal** for rectangular sleeves with the following minimum metal thickness:
 - 1) **For sleeve cross-section rectangle perimeter less than 50 inches** and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).
 - 2) **For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches** and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).
 - d. **Schedule 40 PVC pipe sleeves** are acceptable for use in areas without return air plenums.
 2. **Seal elevated floor, exterior wall and roof penetrations** watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

- C. Interior Foundation Penetrations: Provide sleeves for horizontal pipe passing through or under foundation. Sleeves shall be cast iron soil pipe two nominal pipe sizes larger than the pipe served.
- D. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2-inch of sealant. Refer to Division 21 Section "Common Work Results for Fire Suppression" for materials and installation.
 - 1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1-inch annular clear space between inside of sleeve and outside of insulation.
- E. Exterior Wall Penetrations: Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2-inch of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
 - 1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1-inch annular clear space between inside of sleeve and outside of insulation.
- F. Fire / Smoke Rated Floor and Wall Assemblies: Seal around penetrations of fire rated assemblies to maintain fire resistance rating of assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 21 Section "Common Work Results for Fire Suppression" for firestopping and materials.

3.07 ACOUSTICAL PENETRATIONS

- A. General: There shall be no direct contact of piping with shaft walls, floor slabs and/or partition. All openings around pipes in the structure surrounding the Fire Suppression equipment and surrounding noise-critical spaces shall be sealed, packed with caulking for the full depth of the penetration, as described herein. This includes all slab penetrations and penetrations of noise critical walls.
- B. Fire Sprinkler Piping
 - 1. Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. The internal diameter of the sleeve shall be 2 inches larger than the external diameter of the pipe passing through it. After all of the piping is installed in that area, the Contractor shall check the clearance and correct it, if necessary, to within 1/2 inch. Pack the void full depth with packing material sealed at both ends, 1 inch deep, with non-hardening sealant backed by foam rod.

3.08 PIPE FIELD QUALITY CONTROL

- A. Testing: Refer to individual piping system specification sections.

END OF SECTION 21 05 15

SECTION 21 05 48 SEISMIC CONTROLS FOR FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL REQUIREMENTS

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 RELATED SECTIONS INCLUDE THE FOLLOWING:

- A. Division 20 Section "Seismic Controls for MEP/F/T Systems" for general requirement and related documents that apply to this section.

1.03 DEFINITIONS

- A. The IBC: International Building Code.
- B. ICC-ES: International Code Council Evaluation Service.

1.04 SUMMARY

- A. Seismic bracing, restraints, and controls for all fire protection systems specified herein shall be designed and installed as required by Division 20 Section "Seismic Controls for MEP/F/T Systems".

1.05 SUBMITTALS

- A. Provide submittals as required by Division 20 Section "Seismic Controls for MEP/F/T Systems" for all fire protection systems specified herein.

PART 2 - PRODUCTS AND MATERIALS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 21 05 48

SECTION 21 13 13 WATER BASED FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. The extent of this fire sprinkler system shall be as specified herein. Contractor shall be responsible for preparation of design drawings, hydraulic calculations, fabrication and installation for complete fire sprinkler protection for the building.
- B. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire protection valves.
 - 3. Sprinkler pipe fittings.
 - 4. Sprinklers.
 - 5. Alarm devices.
- C. Related Sections:
 - 1. Division 21 Section 210010 "General Fire Suppression Requirements" for requirements for hydraulic calculations, obtaining electronic drawings files, shop drawings and record drawings.
 - 2. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.
 - 3. Division 21 Section 210515 "Basic Fire Suppression Piping Material and Methods," for general piping and fitting materials and methods.
 - 4. Division 21 Section 210548 "Seismic Controls for Fire Protection" for seismic bracing requirements.

1.02 SYSTEM DESCRIPTION

- A. Fire protection system in the location or portion of the building is a Wet Pipe System.
 - 1. Wet Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to a water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts a fusible link or destroys a frangible device. Hose connections are included if indicated.
- B. Provide system(s) as specified herein and as shown on drawings. The sprinkler system shall be supplied by the fire suppression system that is existing to remain as seen on site.
- C. Provide dry pipe fire protection system for non-heated spaces and other areas of building subject to freezing including the loading docks and canopies, mansards, and balconies. Portions of systems subject to freezing or temperatures below 40° F shall be protected against freezing as required by NFPA 13. The Contractor shall be responsible for repairs and for all costs incurred from damage caused by freezing of the fire protection system.

1.03 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design fire suppression system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Standard Pressure, Fire Suppression System Component: Listed for 175-psig minimum working pressure.
- C. Performance Criteria
 - 1. Protect entire area of work, unless noted otherwise, with a sprinkler system designed in accordance with NFPA 13 for Light Hazard requirements.

2. Protect mechanical and electrical areas/rooms with a sprinkler system designed in accordance with NFPA 13 for Ordinary Hazard Group 1 requirements.
3. Protect storage areas/rooms, unless noted otherwise, with a sprinkler system designed in accordance with NFPA 13 for Ordinary Hazard Group 2 requirement.
4. Design Criteria for Automatic-Sprinkler Piping Design:
 - a. Light Hazard Occupancy:
 - 1) Minimum Design Density: 0.10 gpm over 1,500 sq.ft. area.
 - 2) Maximum protection area per sprinkler: 225 sq.ft.
 - 3) Minimum Combined Hose Stream Demand Requirement: 100 gpm for 30 minutes.
 - b. Ordinary Hazard Group 1 Occupancy (Open areas):
 - 1) Minimum Design Density: 0.12 gpm over 3,000 sq.ft. area.
 - 2) Maximum area per sprinkler: 130 sq.ft..
 - 3) Minimum Combined Hose Stream Demand: 250 gpm for 60 to 90 minutes.
 - c. Ordinary Hazard Group 1 Occupancy (Partitioned Areas):
 - 1) Minimum Design Density: 0.14 gpm over 2,000 sq.ft. area.
 - 2) Maximum area per sprinkler: 130 sq.ft..
 - 3) Minimum Combined Hose Stream Demand: 250 gpm for 60 to 90 minutes.
 - d.
 - e. Ordinary Hazard Group 2 Occupancy:
 - 1) Minimum Design Density: 0.17 gpm over 3,000 sq.ft. area.
 - 2) Maximum protection area per sprinkler: 130 sq.ft.
 - 3) Minimum Combined Hose Stream Demand: 250 gpm for 60 to 90 minutes.
- D. The criteria listed herein shall not preclude the use of extended coverage or special application fire sprinklers designed and installed in accordance with their listing and manufacturer's instructions.
- E. The hydraulic area of operation may not be reduced as allowed by NFPA 13 for areas utilizing quick response sprinklers in unfinished shell spaces. For all other areas, the hydraulic area of operation shall not be reduced as allowed by NFPA 13 for areas utilizing quick response sprinklers unless specifically approved by the Engineer via a formally submitted RFI.
- F. Sprinkler spacing shall conform to NFPA 13 and shall not exceed 256 SF per sprinkler in unfinished shell spaces.
- G. The hydraulic area of operation shall be increased by 30% without revising the density for areas with sloped ceilings with a pitch exceeding 1 in 6 (16.7% slope) in accordance with NFPA 13.
- H. The hydraulic area of operation shall be increased by 30% without revising the density for dry-pipe and double interlock preaction systems in accordance with NFPA 13.

1.04 SUBMITTALS

- A. Submit shop drawings prepared in accordance with NFPA 13 as specified in Division 21 Section 210010 "General Fire Suppression Requirements."
- B. Contractor to submit engineer approved sprinkler shop drawings to HCA's insuring agency, AIG, for review. Email plans to planreview.americas@aig.com and copy james.dipaoli@aig.com. Anthony's alternate contact information is:

Jamie DiPaoli, PE

99 High Street, 24h Floor, Boston MA 02110

Tel +1 617 457 5847 | Cell +1 862 245 3572

1.05 QUALITY ASSURANCE

- A. Contractor shall be responsible for all permits and fees associated with preparation and approval of Drawings and the installation and approval of a fire sprinkler system.
- B. Tests and Inspections: Arrange, test, and pay for all tests required by code and authorities having jurisdiction.

1.06 PROJECT CONDITIONS

- A. Interruption of Existing Fire Sprinkler Protection: Do not interrupt fire sprinkler system protection to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire sprinkler protection according to requirements indicated:
 - 1. Notify Owner no fewer than five days in advance of proposed interruption of fire-sprinkler protection.
 - 2. Do not proceed with interruption of fire sprinkler protection without Owner's written permission.

1.07 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.08 EXTRA MATERIALS

- A. Sprinkler Wrenches: Furnish to Owner, 2 sprinkler wrenches for each type of sprinkler installed.
- B. Sprinklers: Furnish extra sprinklers of each style, type and finish included in the project as required by NFPA 13.
- C. Sprinkler Cabinet and Wrench: Provide a finished steel cabinet(s), suitable for wall mounting, with hinged cover and space for the quantity of spare sprinklers provided plus sprinkler wrench(es).
- D. Provide hydraulic calculation placard attached to each riser.

PART 2 - PRODUCTS AND MATERIALS

2.01 EQUIPMENT

- A. All fire protection equipment shall be UL listed for its intended use and in conformance with the applicable NFPA documents.

2.02 PIPE AND FITTING MATERIALS

- A. Refer to Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for specifications on piping and fittings.

2.03 HANGERS

- A. Shall be UL listed and shall meet requirements of NFPA 13 for type, dimension and location.

2.04 GENERAL DUTY VALVES

- A. Refer to Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for specifications on general duty valves.

2.05 SPECIALTY VALVES

- A. General Requirements:
 - 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by Factory Mutual, approval.
 - 2. Pressure Rating:
 - a. Standard Pressure Piping Specialty Valves: 175-psig minimum.
 - 3. Body Material: Cast- or ductile- iron.
 - 4. Size: Same as connected piping.

5. End Connections: Flanged or grooved.

2.06 PIPE FITTINGS

- A. Branch Outlet Fittings:
 1. Standard: UL 213.
 2. Pressure Rating: 175-psig minimum.
 3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
 4. Type: Mechanical-T and -cross fittings.
 5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
 6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
 7. Branch Outlets: Grooved, welded or threaded.
- B. Flow Detection and Test Assemblies:
 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, approval.
 2. Pressure Rating: 175-psig minimum.
 3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
 4. Size: Same as connected piping.
 5. Inlet and Outlet: Grooved or threaded.
- C. Sprinkler Inspector's Test Fittings:
 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, approval.
 2. Pressure Rating: 175-psig minimum.
 3. Body Material: Cast- or ductile-iron housing with sight glass.
 4. Size: Same as connected piping.
 5. Inlet and Outlet: Threaded.

2.07 AUTOMATIC SPRINKLERS

- A. Sprinklers: type and style as indicated or required by application. Sprinkler operating temperatures to comply with NFPA 13. Sprinklers in Light Hazard areas shall be quick response type.
- B. General Requirements:
 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, approval.
 2. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- C. Automatic Sprinklers with Heat-Responsive Element:
 1. Early-Suppression, Fast-Response Applications: UL 1767.
 2. Nonresidential Applications: UL 199.
 - 3.
 4. Characteristics: Nominal 1/2-inch orifice with discharge coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- D. Use sprinkler types below for the following applications:
 1. Rooms without Ceilings: Upright sprinklers.
 2. Rooms with Suspended Ceilings: Match Existing.
 3. Rooms with Gypsum Board Ceilings: Match Existing.
 4. Wall Mounting: Sidewall sprinklers.

- 5. Spaces Subject to Freezing: Dry pendent or dry sidewall sprinklers as indicated on drawings.
- E. Provide sprinkler types below with finishes indicated.
 - 1. Finished Areas:
 - a. Concealed Sprinklers: Rough brass, with Match Existing
 - b. Recessed Sprinklers: Match Existing
 - c. Unfinished Areas: Rough bronze in unfinished spaces not exposed to view.
- F. Coordinate sprinkler temperature ratings near heat-producing sources in accordance with NFPA 13.
- G. Sprinklers shall be wax coated where exposed to acids, chemicals, or other corrosive fumes.
- H. Sprinkler Guards: Provide sprinkler guard where sprinklers are less than 7-feet above finished floor; where subject to physical damage, and/or where indicated on drawings. Guard shall be UL 199 listed, wire cage type with fastening device for attaching to sprinkler.
- I. Sprinkler Cabinet and Wrench: Provide a finished steel cabinet, suitable for wall mounting, with hinged cover and space for the appropriate quantity of spare sprinklers plus sprinkler wrench(es).

2.08 ALARM DEVICES

- A. Existing to remain. Water Flow Indicators:
 - 1. Standard: UL 346.
 - 2. Water-Flow Detector: Electrically supervised.
 - 3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory set, field-adjustable retard element to prevent false signals and tamperproof cover.
 - 4. Type: Paddle operated.
 - 5. Pressure Rating: 250 psig.
 - 6. Design Installation: Horizontal or vertical.
 - 7. Design Operation: Rising pressure signals excessive supervisory air pressure within the system piping, with lowering pressure signals lack of air pressure within the system piping.
- B. Valve Supervisory Switches:
 - 1. Standard: UL 346.
 - 2. Type: Electrically supervised.
 - 3. Components: Single-pole, double-throw switch with normally closed contacts and tamperproof cover.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

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

3.02 PREPARATION

- A. Perform fire hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

3.03 WATER SUPPLY CONNECTION

- A. Connect sprinkler piping to building's interior water distribution piping. Comply with requirements in Division 22 Section 221116 "Domestic Water Piping" for interior piping.

3.04 PIPE APPLICATIONS

- A. Piping Above Grade: Refer to Division 21 Section 210515 "Basis Fire Suppression Piping Materials and Methods."

3.05 PIPING INSTALLATIONS

- A. Refer to Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for general fire suppression piping installation requirements.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Hangers and Supports: Comply with the requirements of NFPA 13. Hanger and support spacing and locations for piping joined with grooved mechanical couplings shall be in accordance with the grooved mechanical coupling manufacturer's written instructions, for rigid systems. Provide protection from damage where subject to earthquake if required by the applicable building code, designed in accordance with NFPA 13. Locate hangers at or directly adjacent to the joist panel points. Provide two nuts on threaded supports to securely fasten the support.
- D. Install test connections sized and located in accordance with NFPA 13 complete with shutoff valve. Test connections may also serve as drain pipes.
- E. Install pressure gauge on the riser or feed main at or near each test connection. Provide pressure gauge with a connection not less than 1/4 inch and having a soft metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they will not be subject to freezing.
- F. Fill wet-type sprinkler system piping with water.
- G. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods"
- H. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods."

3.06 PIPE JOINT CONSTRUCTION

- A. Refer to Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for general pipe joint construction requirements.

3.07 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable water supply sources.

3.08 SPRINKLER INSTALLATIONS

- A. Use proper tools to prevent damage during installations.
- B. Areas with ceilings: Install sprinklers not less than 6-inches from the edge of a ceiling tile in areas with suspended ceilings, in a symmetrical pattern with lights and outlets.
- C. Install sprinklers in a symmetrical pattern with lights and outlets in all other areas with ceilings.
- D. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- E. Do not install more than one sprinkler on a one inch outlet unless hydraulic calculations are included to verify performance.

3.09 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and Division 21 Section 210553 "Identification for Fire Suppression Piping and Equipment."

- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.10 FIELD QUALITY CONTROL

- A. Perform required tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire alarm tests. Operate as required.
 - 6. Verify that equipment hose threads are same as local fire department equipment.
- C. Replace piping system components that do not pass the test procedures specified, and retest repaired portion of the system.

3.11 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.12 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.13 COMMISSIONING

- A. Sprinkler Systems: Test per NFPA 13, NFPA 25 and local authorities requirements. Submit Contractor's Material & Test Certificates for Above Ground Piping. Submit certificates of completion to Authority Having Jurisdiction and Owner.
 - 1. After completion of all installation, tests, etc., and prior to the opening date, the Sprinkler Subcontractor shall instruct the building personnel in the operation of the sprinkler system. Special care shall be taken to make sure the building personnel:
 - a. Will immediately recognize whether the system control valves are in an 'Open' position or a 'Closed' position.
 - b. Will know how to drain the system.
 - c. Will know how to test the flow switches, tamper switches and alarm system.
 - d. Will know how to make complete weekly inspection.
 - e. Will know how to perform periodic maintenance of the Fire Sprinkler System.
- B. Fire Alarm Equipment: Test per NFPA 25, NFPA 72 and local authorities requirements in the presence of the Owner. Submit certificates of completion to authority having jurisdiction and Owner.

END OF SECTION 21 13 13

SECTION GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.01 DESCRIPTION OF WORK

- A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.
- B. Division 22 of the Specifications and Drawings numbered with prefixes P, MP and EP generally describe these systems, but the scope of the Plumbing work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.02 QUALITY ASSURANCE

- A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturer's requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.03 CODES, REFERENCES AND STANDARDS

- A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.
- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.
- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

UPC	Uniform Plumbing Code – 2018
IECC	International Energy Conservation Code
ADA	American Disabilities Act
AIA	Guidelines for Design and Construction of Hospital and Healthcare Facilities
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
MSS	Manufacturer's Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturers' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
UL	Underwriter's Laboratories

- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. All Plumbing work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the Plumbing work shall be provided by the Contractor.

1.04 DEFINITIONS

A. General:

1. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."
2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."
4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
 - a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
9. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
- C. The following definitions apply to excavation operations:
 1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
 2. Bedding: as used in this Section refers to the compacted sand or pea gravel installed in the bottom of a pipe trench to immediately support a pipe and cover a pipe.
 3. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
 4. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
 5. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

1.05 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.
- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.
- C. The contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.

- D. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the Plumbing systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.
- E. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.06 MEASUREMENTS AND LAYOUTS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.07 SUBMITTALS

- A. Refer to Division 1 and General Conditions for submittal requirements in addition to requirements specified herein.
- B. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- C. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples and other submittals required by this Division as noted in Table 1 at the end of this Section. Provide the number of submittals required by Division 1; if hard-copy sets are provided, submit a minimum of seven (7) sets. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- D. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- E. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- F. Refer to individual Sections for additional submittal requirements.
- G. Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time, plus to/from mailing time via the Architect, plus a duplication of this time for resubmittals, if required. Transmit submittals as soon as possible after Notice to Proceed and before Plumbing construction starts.
- H. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- I. Submittals shall contain the following information:
 - 1. The project name.
 - 2. The applicable specification section and paragraph.
 - 3. Equipment identification acronym as used on the drawings.

4. The submittal date.
 5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
 6. Submittals not so identified will be returned to the Contractor without action.
- J. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow for the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.
- K. The checking and subsequent acceptance by the Engineer and/or Architect of submittals shall not relieve responsibility from the Contractor for (1) deviations from the Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Architect prior to implementing any deviation.
- L. Provide welders' qualification certificates.

1.08 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.09 SUBSTITUTIONS

- A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.
- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:
1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
 - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.

- c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
 - d. Same warranty will be furnished for proposed substitution as for specified Work.
 - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
 - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.
- E. Substitution Consideration:
- 1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
 - 2. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.
 - 3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
 - 4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.10 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- E. Each manual shall contain data listed in Table 5.
- F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives.

1.11 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections in Division 22 of this specification. Refer to Table 2 at the end of this section for a list of specification sections in Division 22 that contain spare parts requirements.
- B. Owner or Owner's representative shall initial and date each section line in Table 2 when the specified spare parts for that section are received and shall sign at the bottom when all spare parts have been received.

1.12 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension, from column lines.
- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.13 TRAINING

- A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video tape the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.14 PAINTING

- A. Exposed ferrous surfaces, including pipe, pipe hangers, equipment stands and supports [and exposed insulated piping] shall be painted by the Plumbing Contractor using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.
- B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.
- C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.15 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 1 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.
- D. The Contractor shall be responsible for the safe storage of his own tools, material and equipment.

1.16 GUARANTEES AND WARRANTIES

- A. Refer to Division 1 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.
- B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.
- C. The following additional items shall be guaranteed:
 - 1. Piping shall be free from obstructions, holes or breaks of any nature.

2. Insulation shall be effective.
3. Proper circulation of fluid in each piping system.
- D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.
- E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.
- F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term. Refer to Table 3 at the end of this section for a list of specification sections in Division 22 that contain special warranties.

1.17 TEMPORARY FACILITIES

- A. Refer to Division 1 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.
- B. Temporary Utilities: The types of services required include, but are not limited to, water, sewerage, surface drainage and gas. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.
- C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.
 1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.

1.18 PROJECT CONDITIONS

- A. Conditions Affecting Work In Existing Buildings:
 1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting His bid to determine the nature and extent of work involved.
 2. Work in the existing building shall be scheduled with the Owner.
 3. Certain demolition work must be performed prior to the remodeling. The Plumbing Contractor shall perform the demolition which involves Plumbing and Plumbing systems, fixtures, equipment, piping, equipment supports or foundations and materials.
 4. Plumbing Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Plumbing Contractor during this demolition shall become his property and shall be removed by the Plumbing Contractor from the premises and dispose of them in accordance with applicable federal, state and local regulations.
 5. Plumbing Contractor shall relocate and reconnect Plumbing facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Plumbing equipment or materials are removed, the Plumbing Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.
 6. General Contractor shall install finish material.
 7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
 8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

9. Locate, identify, and protect Plumbing services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Conditions Affecting Excavations: The following project conditions apply:
 1. Maintain and protect existing building services which transit the area affected by selective demolition.
 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
- C. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.
- D. Use of explosives is not permitted.
- E. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - NOT USED

PART 3 - EXECUTION

3.01 PERMITS

- A. Secure and pay for permits required in connection with the installation of the Plumbing Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.02 EXISTING UTILITIES

- A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.
- B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.
- C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.
- D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.
- E. Contractor shall include in his bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.03 SELECTIVE DEMOLITION

- A. Refer to Division 01, Division 02 and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.
- B. General: Demolish, remove, demount, and disconnect abandoned Plumbing materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- C. Materials and Equipment To Be Salvaged: Remove, demount, and disconnect existing Plumbing materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

- E. Plumbing Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete piping, fittings and specialties, equipment, controls, fixtures and insulation.
 - a. Piping embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.
 - b. Perform cutting and patching required for demolition in accordance with Division 1, General Conditions and "Cutting and Patching" portion of this Section in Division 22.

3.04 CUTTING AND PATCHING

- A. The Contractor shall do necessary cutting of walls, floors, ceilings and roofs.
- B. No structural member shall be cut without permission from Architect.
- C. Patch around openings to match adjacent construction.
- D. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

3.05 CLEANING

- A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Plumbing Contractor shall cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to the final inspection, the Plumbing Contractor shall clean material and equipment installed under the Plumbing Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.06 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:
 - 1. Submit complete Operation and Maintenance Manuals.
 - 2. Submit complete Record Drawings.
 - 3. Perform special inspections. Refer to Table 4 at the end of this section for a list of specification sections in Division 22 that contain special inspection requirements.
 - 4. Start-up testing of systems.
 - 5. Removal of temporary facilities from the site.
 - 6. Comply with requirements for Substantial Completion in the "General Conditions".
- B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.
- C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, He shall reimburse the Architect/Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

- H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. He shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 22 00 10

TABLE 1: PLUMBING SPECIFICATION SHOP DRAWING SUBMITTAL REQUIREMENTS

SPECIFICATION NUMBER/TITLE	CODE DESIGNATION
220010 General Plumbing Requirements	NONE
220015 Coordination	NONE
220500 Common Work Results For Plumbing	A, B, G, M
220515 Basic Piping Materials And Methods	B, G
220523 General-Duty Valves For Plumbing Piping	B
220529 Hangers And Supports For Plumbing Piping	B, F, G, H
220553 Identification For Plumbing Piping & Equipment	B, L, M
220700 Plumbing Insulation	B, M
221100 Water Distribution Piping & Specialties	B, G, H
221300 Sanitary Drainage & Vent Piping & Specialties	B
224000 Plumbing Fixtures	B, E, N
226100 Gas & Vacuum Systems For Medical Facilities	B, C, E, F, G

CODED LEGEND

A	Shop Drawings	G	Welder's Certificates
B	Product Data and equipment weights	H	Certificates
C	Performance Data, Curves, Certificates and Test Data	I	Calculations
D	Coordination Drawings	J	Special Inspections
E	Wiring Diagrams and short circuit current ratings	K	Special Warranties
F	Installation Instructions	L	Material Samples
		M	Schedules
		N	Recommended Spare Parts List

TABLE 2: SPARE PARTS REQUIREMENTS FOR PLUMBING EQUIPMENT

Section Number	Received/Date/Initial
220553 Identification For Plumbing Piping & Equipment	_____
221100 Water Distribution Piping & Specialties	_____
224000 Plumbing Fixtures	_____
22610 Gas & Vacuum Systems For Medical Facilities	_____

Owner's Signature

TABLE 3: SPECIAL WARRANTY REQUIREMENTS FOR PLUMBING EQUIPMENT

Section Number	Received/Date/Initial
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TABLE 4: SPECIAL INSPECTION REQUIREMENTS FOR PLUMBING EQUIPMENT

Section Number	Completed/Date/Initial
226100 Gas & Vacuum Systems For Medical Facilities	<hr/>

TABLE 5: PLUMBING SPECIFICATION OPERATION AND MAINTENANCE SUBMITTAL REQUIREMENTS

SPECIFICATION NUMBER/TITLE		CODE DESIGNATION
220500	Common Work Results For Plumbing	B
220515	Basic Piping Materials And Methods	B
220523	General-Duty Valves For Plumbing Piping	B, H, I
220529	Hangers And Supports For Plumbing Piping	B
220553	Identification For Plumbing Piping & Equipment	B
220700	Plumbing Insulation	B
221100	Water Distribution Piping & Specialties	A, B, F, H, I
221300	Sanitary Drainage & Vent Piping & Specialties	A, B, F
224000	Plumbing Fixtures	B, E, H, I
226100	Gas & Vacuum Systems For Medical Facilities	A, B, C, D, E, G, H, I

CODED LEGEND

A	As-Built Drawings	E	Operating Instructions
B	Product Data	F	Test Reports
C	Performance Data, Capacities, Curves and Certificates	G	Warranties
D	Wiring Diagrams	H	Recommended Spare Parts List
		I	Service and Maintenance Instructions

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

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

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Architect: _____

Address: _____ Owner: _____

Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____	_____	_____
Submitting Contractor	Date	Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____	_____	_____
Manufacturer's Representative	Date	Company

Engineer Review and Recommendation Section

Recommend Acceptance	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Additional Comments:	<input type="checkbox"/> Attached	<input type="checkbox"/> None

Acceptance Section:

_____	_____	_____
Contractor Acceptance Signature	Date	Company
_____	_____	_____
Owner Acceptance Signature	Date	Company
_____	_____	_____
Architect Acceptance Signature	Date	Company
_____	_____	_____
Engineer Acceptance Signature	Date	Company

SECTION 22 00 15 COORDINATION

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section specifies the basic requirements for electrical components which are an integral part of packaged plumbing equipment. These components include, but are not limited to factory furnished motors, starters, and disconnect switches furnished as an integral part of packaged plumbing equipment.
- B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for plumbing equipment are scheduled on the Drawings.
- C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.02 SUBMITTALS

- A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

1.03 QUALITY ASSURANCE

- A. Electrical components and materials shall be UL labeled.
- B. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

PART 2 - PRODUCTS AND MATERIALS

2.01 GENERAL

- A. The Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Plumbing Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, the Plumbing Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.
- B. Refer to Division 26, "Common Work Results for Electrical" for specification of motor connections
- C. Refer to Division 26, "Enclosed Switches and Circuit Breakers" for specification of disconnect switches.

PART 3 - EXECUTION

3.01 CONTRACTOR COORDINATION

- A. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with Table 1. Any items not listed but shown on the drawings shall be considered part of the Contract Documents and brought to the attention of the Architect.
- B. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

TABLE 1: ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

ITEM	FURN BY	SET BY	POWER WIRING	CONTROL WIRING
Loose motor starters, disconnect switches, thermal overloads and heaters.	DIV 26	DIV 26	DIV 26	DIV 23
Factory assembled control panels	DIV 22	DIV 26	DIV 26	DIV 23

DIV 22 = Plumbing Contractor

DIV 26 = Electrical Contractor

DIV 23 = Building Automation System Contractor, refer to Division 23 Section "Direct-Digital Control for HVAC".

END OF SECTION 22 00 15

SECTION 22 05 00 COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes limited scope general construction materials and methods for application with Plumbing installations as follows:
 - 1. Access panels and doors in walls, ceilings, and floors for access to Plumbing materials and equipment.
 - 2. Plumbing equipment nameplate data.
 - 3. Concrete for bases and housekeeping pads.
 - 4. Non-shrink grout for equipment installations.
 - 5. Sleeves for Plumbing penetrations.
 - 6. Miscellaneous metals for support of Plumbing materials and equipment.
 - 7. Wood grounds, nailers, blocking, fasteners, and anchorage for support of Plumbing materials and equipment.
 - 8. Joint sealers for sealing around Plumbing materials and equipment.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.
 - 2. Division 22 Section "Basic piping Materials and Methods" for materials and methods for mechanical sleeve seals.
 - 3. Division 22 Section "Sanitary Drainage and Vent Piping and Specialties" for indirect drain piping and installation requirements.
 - 4. Division 23 Section "Direct Digital Controls for HVAC" for integration with building automation system of leak detection system "Water Present" alarm.
 - 5. Division 26 Section "Common Work Results for Electrical" required electrical devices.
 - 6. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.02 SUBMITTALS

- A. General: Submit the following in accordance with Division 1 and Division 22 Section "General Plumbing Requirements".
 - 1. Product data for the following products:
 - a. Access panels and doors.
 - b. Through and membrane-penetration firestopping systems.
 - c. Joint sealers.
 - 2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for Plumbing materials and equipment.
 - 3. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.
 - 4. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
 - a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 1 Section "Summary of Work."

5. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
 - a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.03 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
 1. Provide UL Label on each fire-rated access door.
- C. Through and Membrane Penetration Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

1.04 NOISE CRITICAL SPACES

- A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces; noise levels due to equipment, ductwork, grilles, registers, terminal devices, diffusers, etc., shall permit attaining sound pressure levels in all 8 octave bands in occupied spaces conforming to RC levels per ASHRAE handbook as indicated.

Space	RC Levels
Teleconference Rooms	25
Conference Rooms	30

PART 2 - PRODUCTS AND MATERIALS

2.01 ACCESS TO EQUIPMENT

- A. Access Doors:
 1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section "Identification for Plumbing Piping" for labeling of access doors.
 2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
 3. Access doors must be of the proper construction for type of construction where installed.
 4. The exact location of all access doors shall be verified with the Architect prior to installation.
 5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
 - b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
8. Locking Devices: Flush, screwdriver-operated cam locks.
9. Locking Devices: Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

2.02 PLUMBING EQUIPMENT NAMEPLATE DATA

- A. For each piece of power operated Plumbing equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

2.03 PENETRATIONS

- A. Sleeves:
 1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.
 2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.
- B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.
- C. Box Frames: Frames for rectangular openings shall be of welded 12 gauge steel attached to forms and of a maximum dimension established by the Architect. Contractor shall notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

2.04 DRIP PANS

- A. Drip pans for pipes in protected areas shall be 20 gauge galvanized steel with 2" lapped and soldered joints. Drip pan shall have a depth of 2" and a width of 6" in addition to the diameter of the associated pipe. Provide 3/4" galvanized pipe with male NPT outlet at low point of drip pan.
- B. Drip pan supports shall be 1/4" X 2" galvanized bar stock welded to the drip pan without holes.
- C. Leak Detection System: Rope style leak sensor and controller capable of connecting to a building automation system with audible and visual alarms for leak detection in all drip pans unless otherwise noted on drawings. Provide with factory 24V DC power supply with power plug, sensing cables, and accessories.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. RLE Technologies #LD1000

2.05 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Fasteners: Zinc-coated, type, grade, and class as required.

2.06 MISCELLANEOUS LUMBER

- A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPB rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.
- B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches.

2.07 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 1. Architectural Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 3. Sealant Primers for Porous Substrates: 775 g/L.
- C. Colors: As selected by the Architect from manufacturer's standard colors.
- D. Elastomeric Joint Sealers: Provide the following types:
 1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:
 - a. "Dow Corning 790," Dow Corning Corp.
 - b. "Silglaze II SCS 2801," General Electric Co.
 - c. "Silpruf SCS 2000," General Electric Co.
 - d. "864," Pecora Corp.
 - e. "Rhodia 5C," Rhone-Poulenc, Inc.
 - f. "Spectrem 1," Tremco, Inc.
 - g. "Spectrem 2," Tremco, Inc.
 - h. "Dow Corning 795," Dow Corning Corp.
 - i. "Rhodia 7B," Rhone-Poulenc, Inc.
 - j. "Rhodia 7S," Rhone-Poulenc, Inc.
 - k. "Omniseal," Sonneborn Building Products Div.
 2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:
 - a. "Dow Corning 786," Dow Corning Corp.

- b. "Sanitary 1700," General Electric Co.
 - c. "898 Silicone Sanitary Sealant," Pecora Corp.
- E. Acrylic-Emulsion Sealants: One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent. Provide one of the following:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Chem-Calk 600," Bostik Construction Products Div.
 - b. "AC-20," Pecora Corp.
 - c. "Sonolac," Sonneborn Building Products Div.
 - d. "Tremflex 834," Tremco, Inc.

2.08 ACOUSTICAL SEALANTS

- A. General: Penetrations by pipes through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.
- B. Foam Rod: Foam backer rod shall be closed cell polyethylene suitable for use as a backing for non-hardening sealant.
- C. Non-Hardening Sealant: Sealant for penetrations shall be non-hardening polysulphide type. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.
- D. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 pcf (40 kg/m3).

2.09 PLENUM INSULATION

- A. General: Combustible materials including, but not limited to, plastic pipe and plastic-coated cables that do not meet the minimum combustibility requirements of the applicable building codes may be installed in fire-rated return air plenums when enclosed within high-temperature insulation blanket where approved by the authority having jurisdiction.
- B. Material: FyreWrap 0.5 Plenum Insulation, ETS Schaefer Plenumshield Blanket, or equivalent utilizing light weight, high temperature blanket enhanced for biosolubility. The encapsulating material shall be aluminum foil with fiberglass reinforcing scrim covering.
- C. Certification: Plenum insulation shall have an encapsulated flame spread rating less than 25 and a smoke developed rating of less than 50. The product shall be UL 1887 (Modified) listed, certified by ASTM E-136 for Non-combustibility and ASTM E-84/UL 723 for Surface Burning Characteristics.
- D. Physical Properties: Plenum insulation shall be single ½" layer with a density of 6 to 8 pounds per cubic foot.

2.10 FIRESTOPPING

- A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, or other NRTL acceptable to AHJ. Manufactured by:
 - 1. Hilti
 - 2. RectorSeal
 - 3. Specified Technologies Inc.,
 - 4. United States Gypsum Company
 - 5. 3M Corp.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install access doors and sealants in accordance with manufacturer's installation instructions.

3.02 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

3.03 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.04 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.05 PREPARATION FOR JOINT SEALERS

- A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.06 APPLICATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - 2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
- B. Tooling: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.07 PENETRATIONS:

- A. New Construction:
 - 1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support piping or ductwork penetrations.
- B. Construction in Existing Facilities:
 - 1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.
- C. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.

- D. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.
- E. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.
- F. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.
- G. Cut sleeves to length for mounting flush with both surfaces of walls.
- H. Extend sleeves installed in floors 2 inches above finished floor level.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- J. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.
- K. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 22 Section "Basic Piping Materials and Methods".

3.08 DRIP PANS

- A. Provide drip pans in locations indicated on drawings.
- B. Provide drip pans for piping directly above a two hour rated ceiling of an elevator machine room.
- C. Provide drip pans, only with written approval obtained prior to installation, installed beneath piping above electrical rooms, telecom rooms, data rooms, servers or any other protected area not clearly indicated by drawings.
- D. Provide drip pan supports every 4'-0". Provide 1/4" galvanized threaded rods through bar stock on each side of the drip pan and attached with 2 nuts per rod. Attach rods to structure with MSS SP-58 compliant components.
- E. Connect 3/4" type "L" copper indirect drain line to drip pan outlet. Route and discharge to receptor with air gap outside of the protected area.
- F. Install leak detection rope in a zig-zag pattern covering entire length and width of the drip pan. Secure rope to pan per manufacturers recommendations.
- G. Mount leak detection controller on wall adjacent to exit of the room above which the drip pan is located unless otherwise indicated on drawings indicated on drawings.
- H. Coordinate disconnect and power supply for leak detection system and 120V dedicated receptacle adjacent to controller with Division 26. Power wiring and receptacles are specified in Division 26 Section "Common Work Results for Electrical" Disconnects are specified in Division 26 Section "Enclosed Switches and Circuit Breakers"
- I. Coordinate interlock of "Water Present" alarm and "Cable Fault" alarm with Building Automation System. Refer to Division 23 Section "Direct Digital Controls for HVAC" for integration with building automation system and low voltage power wiring.
- J. Interlock control panel with relay at motorized ball valve actuator. Upon receiving leak alarm signal the control panel shall energize motorized ball valve "MBV" to close. Motorized ball valve "MBV" is indicated and specified on the drawings. Relays are provided by electrical.

3.09 ACOUSTICAL PENETRATIONS

- A. General: There shall be no direct contact of piping with shaft walls, floor slabs and/or partition. All openings around pipes in the structure surrounding the plumbing equipment and surrounding noise-critical spaces shall be sealed, packed with caulking for the full depth of the penetration, as described herein. This includes all slab penetrations and penetrations of noise critical walls.
- B. Domestic Water, Sewer, Drain and Vent Piping
 - 1. Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. The internal diameter of the sleeve shall be 2 inches larger than the external diameter of the pipe passing through it. After all of the piping is installed in that area, the Contractor shall check the clearance and correct it, if

necessary, to within 1/2 inch. Pack the void full depth with packing material sealed at both ends, 1 inch deep, with non-hardening sealant backed by foam rod.

END OF SECTION 22 05 00

SECTION 22 05 15

BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section specifies piping materials and installation methods common to more than one Section of Division 22 and includes joining materials, piping specialties and basic piping installation instructions.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "Common Work Results for Plumbing," for materials and methods for sleeve materials.

1.02 DEFINITIONS

- A. 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 Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.03 SUBMITTALS

- A. Refer to Division 1 and Division 22 Section "General Plumbing Requirements" for administrative and procedural requirements for submittals.
- B. Product Data: Submit product data on the following items:
 - 1. Escutcheons
 - 2. Dielectric Unions
 - 3. Wall Pipes
 - 4. Strainers
- C. Quality Control Submittals:
 - 1. Submit welders' certificates specified in Quality Assurance below.
- D. Submit certification that specialties and fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.
- E. Submit a schedule of dissimilar metal joints and dielectric waterway fittings, unions, flanges or flange kits. Include joint type materials, connection method and proposed dielectric waterway fittings, unions and flanges to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Refer to the individual piping system specification sections in Division 22 for specifications for piping materials and fittings relative to that particular system and additional requirements.
- F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.

1.04 QUALITY ASSURANCE

- A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
- B. Welding procedures and testing shall comply with ANSI Standard B31.9 - Standard Code for Building Services Piping and The American Welding Society, Welding Handbook.
- C. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Plumbing Refrigeration.
- D. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.
- E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide piping materials and specialties from one of the following:
1. Pipe Escutcheons:
 - a. AWI Manufacturing.
 - b. Keeney Manufacturing Company
 - c. Wal-Rich Corp.
 - d. Jones Stephens Corp.
 2. Dielectric Unions:
 - a. JOMAR International
 - b. Smith Cooper International
 - c. Watts Regulator Co.
 - d. Zurn Industries
 3. Strainers:
 - a. Armstrong Machine Works.
 - b. Hoffman Specialty ITT; Fluid Handling Div.
 - c. MEPCO
 - d. Metraflex Co.
 - e. Mueller Steam Specialties.
 - f. Nicholson Steam
 - g. RP&C Valve, Division of Conbraco Ind.
 - h. Spirax Sarco.
 - i. Watts Regulator Co.
 - j.
 4. Wall Pipes
 - a. Josam Mfg. Co.
 - b. Smith (Jay R) Mfg. Co.
 - c. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
 - d. Watts Industries, Inc.
 - e. Zurn Industries, Inc.; Hydromechanics Div.

2.02 PIPE AND FITTINGS

- A. Refer to the individual piping system specification sections in Division 22 for specifications on piping and fittings relative to that particular system.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

- A. Refer to individual Division 22 Piping Sections for special joining materials not listed below.
- B. Welding Materials: AWS D10.12; Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
- C. Brazing Materials: AWS A5.8; Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.
- D. Soldering Materials: ASTM B32; Refer to individual piping system specifications for solder appropriate for each respective system.

2.04 PIPING SPECIALTIES

- A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.
- B. Unions:
 - 1. Malleable-iron, Class 150 for low pressure service and class 300 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
 - 2. Bronze, Class 125, with lead free cast bronze body meeting ASTM B584, for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; solder or female threaded ends.
- C. Dielectric Unions: Factory-fabricated with lead free cast bronze body meeting ASTM B584 and galvanized steel body with plastic dielectric gasket, class 125 for low pressure service and class 250 for high pressure service, and appropriate end connections for the pipe materials in which installed (screwed or soldered) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.
- D. Y-Type Strainers: Provide strainers full line size of connecting piping, with ends matching piping system materials. Screens for 4" and smaller shall be Type 304 stainless steel mesh with 0.062" perforations and screens for 5" and larger shall be Type 304 stainless steel, with 0.125" perforations.
 - 1. For low pressure applications, cast iron strainers shall have 125 psi working pressure rating and cast bronze strainers shall have 150 psi working pressure rating. For high pressure applications, cast iron strainers shall have 250 psi working pressure rating and cast bronze strainers shall have 300 psi working pressure rating.
 - 2. Solder Ends, 2" and Smaller: Lead free cast bronze body meeting ASTM B584, screwed screen retainer with centered blowdown fitted with pipe plug.
- E. Sleeves:
 - 1. Sleeve: Refer to Division 22 Section "Common Work Results for Plumbing" for sleeve materials.

2.05 WALL PIPES

- A. Cast-iron sleeve with integral clamping flange with clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's installation instructions.

3.02 PREPARATION

- A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.03 INSTALLATIONS

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

- B. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.
- C. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.
- D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.
- E. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- F. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- G. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.
- H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.
- I. Verify final equipment locations for roughing in.

3.04 PIPING PROTECTION

- A. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.05 PENETRATIONS

- A. Plumbing penetrations occur when piping penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies.
- B. Above Grade Concrete or Masonry Penetrations
 - 1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:
 - a. Provide schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
 - b. Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).
 - c. Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:
 - 1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).
 - 2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).
 - d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.
 - 2. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.
 - 3. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of 1/2" of sealant.
- C. Elevated Floor Penetrations of Waterproof Membrane:

1. Provide cast-iron wall pipes for sleeves, extend top of wall pipe minimum 1" above finish floor. Size wall pipe for minimum 1/2" annular space between pipe and wall pipe.
 2. Extend pipe insulation for insulated pipe through wall pipe. The vapor barrier shall be maintained. Size wall pipe for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.
 3. Pack with mineral wool and seal both ends with minimum of 1/2" of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
 4. Secure waterproof membrane flashing between clamping flange and clamping ring. Comply with requirements for flashing specified in Division 7 Section "Sheet Metal Flashing and Trim."
 5. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.
- D. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2" of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.
- E. Fire / Smoke Rated Floor and Wall Assemblies: Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 22 Section "Common Work Results for Plumbing" for firestoppings and materials.
- F. Acoustical Barrier Penetrations: Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. Refer to Section "Basic Mechanical Materials and Methods" for noise critical spaces. The internal diameter of the sleeve shall be a minimum of 2 inches larger than the external diameter of the pipe. After the piping is installed, the Contractor shall check the clearance and correct it to within 1/2-inch. Contractor shall pack the void full depth with glass/mineral fiber insulation and seal at both ends, 1-inch deep, with sealant backed by foam rod.
1. Penetration of sound isolating ceilings by sprinkler pipes and heads shall be sleeved and sealed and shall have no rigid connections between them.

3.06 FITTINGS AND SPECIALTIES

- A. Use fittings for all changes in direction and all branch connections.
- B. Remake leaking joints using new materials.
- C. Install components with pressure rating equal to or greater than system operating pressure.
- D. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, mixing valve, backflow preventer and elsewhere as indicated.
- E. Install unions at the final connection to each piece of equipment adjacent to each isolation valve or valve assembly for connections 2" and smaller. Install unions where indicated elsewhere on the drawings.
- F. Install flanges at the final connection to each piece of equipment, adjacent to each isolation valve or valve assembly in piping 2-1/2" and larger. Install flanges at each valve 2-1/2" and larger.
- G. Install dielectric unions for piping 2" and smaller or dielectric flanges for piping 2-1/2" and larger to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for copper or brass connected to carbon steel, cast or ductile iron.
- H. Install dielectric unions for piping 2" and smaller or dielectric flanges for piping 2-1/2" and larger to connect piping materials of dissimilar metals in wet piping systems (water) (except do not

install dielectric unions in concealed spaces, instead, install dielectric waterway fittings) for copper or brass connected to carbon steel, cast or ductile iron.

- I. Install dielectric waterway fittings for piping 2" and smaller for copper or brass pipe connections to carbon steel equipment connections.
- J. Install dielectric flanges for piping 2-1/2" and larger for copper or brass pipe connections to carbon steel equipment connections, steel, ductile iron or cast iron valves and fittings.
- K. Dielectric Flange Installation:
 - 1. Provide brass nipples between the equipment connection and dielectric flange for screwed connections. Provide an iron flange for the equipment side and a bronze flange for the copper or brass piping side of the joint.
 - 2. Provide a bronze flange for the copper or brass piping connection to a cast iron, ductile iron or steel flange.
 - 3. Provide full face gasket with pressure rating equal to system served.
 - 4. At each bolt provide, steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

3.07 JOINTS

- A. Non-ferrous Pipe Joints:
 - 1. Brazed And Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.9 - Standard Code for Building Services Piping and ANSI B9.1 - Standard Safety Code for Plumbing Refrigeration.
 - 2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emory cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.
- B. Joints for other piping materials are specified within the respective piping system Sections.

3.08 PIPE FIELD QUALITY CONTROL

- A. Testing: Refer to individual piping system specification sections.
- B. Inspection Report Form: Refer to the inspection report form at the end of this section for inspection data to be completed for each piping system. Submit completed forms to the Owner and Engineer.

END OF SECTION 22 05 15

PLUMBING & PLUMBING PIPING SYSTEMS
INSPECTION REPORT FORM

Project Name: _____
Project No: _____ Contractor Project No. _____
General Contractor: _____
Inspection Date: _____ Temperature: _____

System Inspected

Building: _____
Location/Description: _____
Service: _____

Inspection Results

Time of Inspection: _____
Approval to Insulate: Y N Approval to Cover in Wall: Y N
Approval to backfill Y N

Signatures

Witness: _____ Representing: _____
Witness: _____ Representing: _____
Witness: _____ Representing: _____

Remarks

Contractor Supervisor's signature: _____

SECTION 22 05 16

EXPANSION FITTINGS AND LOOPS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Flexible expansion loops
 - 2. Piped expansion loops
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "Hangers and Supports for Plumbing Piping", for pipe anchors and alignment guides.
 - 2. Division 22 Section "Sanitary Drainage and Vent Piping and Specialties" for shielded transition couplings.

1.02 DEFINITIONS

- A. Pipe sizes used in this Specification are nominal pipe size (NPS).
- B. 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 Safe Drinking Water Act as amended January 4th, 2011 Section 1417.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
 - 1. Product data for each type of pipe expansion joints specified. Submit expansion compensation schedule showing manufacturer's figure number, size, location, connections, material and displacement for each required expansion joint.
 - 2. Assembly-type shop drawings for each type of expansion compensation product, indicating dimensions, weights, required clearances, and methods of assembly of components. Detail fabrication of pipe anchors, hangers, special pipe support assemblies and their attachment to the building structure. Submit calculations of pipe expansion forces at anchor points for structural engineer review.
 - 3. Shop drawings for field-fabricated expansion loops indicating location, dimensions, pipe sizes, calculations for compression or tension required, and location. Detail fabrication of pipe anchors, hangers, special pipe support assemblies and their attachment to the building structure. Submit calculations of pipe expansion forces at anchor points for structural engineer review.
 - 4. Maintenance data for expansion joints for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."
 - 5. Submit certification that expansion joints for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372.
 - 6. Submit American Gas Association certification for expansion joints used for natural gas distribution systems.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following codes:
 - 1. ASME B31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
 - 2. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications" for Qualifications for Welding Processes and Operators.

- B. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.
- C. Expansion joints shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexible Expansion Loops:
 - a. Flex-Hose Co. Inc.
 - b. Flexicraft Industries
 - c. Keflex HVAC Products, Flex-Weld, Inc.
 - d. Metraflex Co.
 - e. Twin City Hose
 - 2. Packless Rubber Expansion Joints:
 - a. Flexider USA
 - b. Garlock Mechanical Packing Div., Colt Industries
 - c. Holz Rubber
 - d. Keflex HVAC Products Div., Flex-Weld, Inc.
 - e. MG Piping Products Co.
 - f. Mason Industries, Inc.
 - g. Metraflex Co.
 - h. Vibration Mountings and Controls, Subsidiary of ARX.

2.02 PIPE EXPANSION JOINTS, GENERAL

- A. Pipe expansion joints shall provide 200 percent absorption capacity of piping expansion between anchors.
- B. Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- C. Fittings: Materials of construction and end fitting type shall be consistent with pipe material and equipment / pipe connection fittings. Copper fittings shall not be attached to stainless steel hose.

2.03 FLEXIBLE EXPANSION LOOPS

- A. Expansion Compensators for domestic distribution water systems: Flexible loops shall consist of two lead free copper 90 degree elbows and one lead free copper 180 degree return assembly, such that the piping does not change direction and maintains course along a single axis. Provide with support nut at the bottom of the 180 degree return assembly for proper positioning, drain plug, and lead free bronze flexible hose and braid. Provide copper sweat ends for 2" and smaller and lead free bronze 150# flanges for 2-1/2" and larger. Units shall be minimum cold working pressure 150 psi. [Units shall be listed and labeled for UPC.]
- B. Expansion Compensators for natural gas distribution systems: Flexible loops shall consist of two carbon steel 90 degree elbows and one carbon steel 180 degree return assembly, such that the piping does not change direction and maintains course along a single axis. Provide with support nut at the bottom of the 180 degree return assembly for proper positioning, drain plug, and stainless steel hose and braid. Provide threaded ends for 2" and smaller and steel 150#

flanges for 2-1/2" and larger. Units shall be cold working pressure 150 psi. Unit shall be specifically designed for natural gas systems and bear the AGA stamp.

- C. Rubber Expansion Joints: Fabric-reinforced EPDM rubber with full-faced integral flanges, external control rods and shall be internally reinforced with steel retaining rings over entire surface of flanges, drilled to match flange bolt holes.

2.04 FLEXIBLE BALL PIPE JOINTS

2.05 EXPANSION LOOPS

- A. Provide pipe expansion loop constructed of main pipe material. Acceptable methods include use of elbows in a U or Z shape as defined by ASHRAE or ASME; or a detailed stress analysis may be utilized to define areas of expansion.

2.06 ALIGNMENT GUIDES AND ANCHORS

- A. Provide alignment guides and anchors as specified in specification Division 22 Section "Hangers and Supports for Plumbing Piping".

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install products in accordance with manufacturer's instructions.
- B. Install expansion joints and expansion loops where indicated on the drawings and where required for adequate expansion of installed piping system.
- C. Install expansion loops in all piping crossing building expansion joints. Expansion loops shall be sized to meet or exceed building expansion as defined in the structural documents. Expansion loops shall be capable of moving in all planes. Provide hangers and supports per manufacturer's instructions.
- D. Anchor piping to ensure proper direction of expansion and contraction
- E. Align joints to avoid end loading and torsional stress.

3.02 FLEXIBLE EXPANSION LOOPS

- A. Install loops at locations indicated on plans. Amount of expansion shall be as indicated on plans. Support loop as required by manufacturer and to prevent binding or sagging per Division 22 Section "Hangers and Supports for Plumbing Piping".
- B. Where required by manufacturer provide hanger or support for 180 degree return fitting.
- C. Flexible hose expansion loops shall impart no thrust loads to system support, anchors or building structure.

3.03 EXPANSION LOOPS

- A. Fabricate expansion loops to dimensions indicated. For thermal expansion loops subject loop to cold spring tension or compression necessary to absorb 50 percent of the total compression or tension during anticipated change in temperature.
- B. Expansion loop locations and dimensions shall be based on routing shown on plans. If routing is modified, coordinate locations with engineer.
- C. Fabricate expansion loops to dimensions indicated on plans.
- D. For thermal expansion loops, install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature. After installation remove temporary space holders as required.
- E. Provide hangers and supports in accordance with Division 22 Section "Hangers and Supports for Plumbing Piping". For expansion loops with horizontal and vertical components, support for the horizontal legs shall be designed for full weight of the pipe with maximum load variation of 25%.
- F. Provide alignment guides at locations indicated on plans and as required for piping expansion. At a minimum, install alignment guides on both sides of expansion loop, spaced at twice the

height of the U or Z loop (height defined as perpendicular distance of piping from primary pipe direction) or as required by the expansion joint manufacturer. Alignment shall be sufficient to allow for proper installation of expansion joints to prevent binding or torsional stress on joint.

- G. Provide anchors at locations indicated on plans and as required for piping expansion. At a minimum install anchors on both sides of straight pipe length incorporating expansion loop.
- H. For gravity drainage systems and vent systems, connect plain end expansion compensators to hubless cast iron with shielded transition couplings. Shielded transition couplings are specified in Division 22 Section "Sanitary Drainage and Vent Piping and Specialties".

END OF SECTION 22 05 16

SECTION 22 05 23

GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes general duty valves common to most mechanical piping systems.
 - 1. Special purpose valves are specified in individual piping system specifications.

1.02 DEFINITIONS

- A. 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 Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
 - 1. Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.
- B. Submit certification that valves for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

1.04 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide products specified in this section from the same manufacturer where products are available and conform to the specification requirements.
- B. American Society of Mechanical Engineers (ASME) Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.
- C. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the various MSS Standard Practices referenced.
- D. Valves shall be manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.
- E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of valves containing no more than 0.25% lead by weight compliance for valves for domestic water distribution.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products from one of the manufacturers listed in valve schedule.

2.02 VALVE FEATURES, GENERAL

- A. Valve Design: Rising stem or rising outside screw and yoke stems.
 - 1. Non-rising stem valves may be used where headroom prevents full extension of rising stems.
- B. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.
- C. Sizes: Same size as upstream pipe, unless otherwise indicated.
- D. Operators: Provide the following special operator features:
 - 1. Handwheels, fastened to valve stem, for valves other than quarter turn.

2. Lever handles, on quarter-turn valves 6-inch and smaller, except for plug valves. Provide plug valves with square heads; provide one wrench for every 10 plug valves.
- E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
- F. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.
- G. End Connections: As indicated in the valve specifications.
 1. Threads: Comply with ANSI B1.20.1.
 2. Solder-Joint: Comply with ANSI B16.18.
 - a. Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F for gate, globe, and check valves; below 421 deg F for ball valves.

2.03 GATE VALVES

- A. Lead Free Gate Valves, 2-Inch and Smaller: Meeting MSS SP-80; Class 125, 200-psi CWP, body, solid wedge and bonnet of ASTM B 584 lead free cast bronze; brass packing gland and stem of ASTM B283 naval brass; with solder ends, non-asbestos composition packing, and malleable iron handwheel.

2.04 BALL VALVES

- A. Lead Free Ball Valves, 2 Inch and Smaller: Meeting MSS SP-110, Class150, 600-psi CWP; two-piece construction; with ASTM B 584 cast lead free bronze, full port, blowout-proof stem and chrome-plated lead free brass ball, with replaceable "Teflon" or "TFE" seats and seals, solder ends and vinyl-covered steel handle.

2.05 CHECK VALVES

- A. Lead Free Swing Check Valves, 2-Inch and Smaller: Meeting MSS SP-80; Class 125, 200-psi CWP, body and cap of ASTM B 584 cast lead free bronze; with horizontal swing, Y-pattern, disc and disc holder of ASTM B 283 alloy C46400 naval brass; solder ends. Provide valves capable of being reground while the valve remains in the line.
- B. Lead Free Lift Check Valves, 2-Inch and Smaller: Meeting MSS SP-80; Class 125, 300-psi CWP, body, disc holder and cap of ASTM B 584 cast lead free bronze; horizontal or angle pattern, lift-type valve, with stainless steel spring, renewable "Teflon" disc and solder ends. Provide valves capable of being refitted and ground while the valve remains in the line.

PART 3 - EXECUTION

3.01 VALVE ENDS SELECTION

- A. Select valves with the following ends or types of pipe/tube connections:
 1. Copper Tube Size, 2-Inch and Smaller: Solder ends.

3.02 VALVE PRESSURE/TEMPERATURE CLASSIFICATION SCHEDULES

- A. VALVES, 2-INCH AND SMALLER

SERVICE	GATE	BALL	CHECK
Domestic Hot and Cold Water	125	150	125

3.03 VALVE SCHEDULE

- A. Lead Free Gate Valves - 2 Inch and Smaller, Class 125:

MANUFACTURER	SOLDER NRS
Apollo	102S-LF
Hammond	UP-668
Milwaukee	UP668
NIBCO	S-113-LF

B. Lead Free Ball Valves (full port) – 2 inch and smaller

MANUFACTURER	SOLDER ENDS	THREADED ENDS
Apollo-(Conbraco)	77C-LF-200	77C-LF-100
Hammond	UP8311A	UP8301A
Milwaukee	UPBA-450	UPBA-400
NIBCO	S-585-80-LF	T-585-80-LF

C. Lead Free Swing Check Valves – 2 inch and smaller, Class 125:

MANUFACTURER	SOLDER ENDS	THREADED ENDS
Apollo	161S-LF	161T-LF
Milwaukee	UP1509	UP509
NIBCO	S-413-Y-LF	T-413-Y-LF

D. Lead Free Lift Check Valves – 2 inch and smaller, Class 150:

MANUFACTURER	SOLDER ENDS	THREADED ENDS
Hammond	UP947	UP943
NIBCO	S-480-Y-LF	T-480-Y-LF

3.04 APPLICATION SCHEDULE

- A. General Application: Use gate, ball, and butterfly valves for shutoff duty; globe, ball, and butterfly for throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements.
- B. Domestic Water Systems: Use the following valve types:
 - 1. Gate Valves: Class 125, NSF 61 Annex G lead free cast bronze or cast-iron body to suit piping system.
 - 2. Ball Valves, 2" And Smaller: Class 150, 600-psi CWP, with stem extension, NSF 61 Annex G lead free cast bronze.
 - 3. Bronze Swing Check: Class 125, NSF 61 Annex G lead free cast bronze, with rubber seat.
 - 4. Check Valves: Class 125, swing or wafer type as indicated.

3.05 VALVE INSTALLATIONS

- A. Locate valves for easy access and provide separate support where necessary. Provide access doors and fire rated access doors as required.
- B. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.
- C. Install three-valve bypass around each pressure reducing valve using throttling-type valves.
- D. Install valves in horizontal piping with stem at or above the center of the pipe.

- E. Install valves in a position to allow full stem movement.
- F. Installation of Check Valves: Install for proper direction of flow as follows:
 - 1. Swing Check Valves: Horizontal position with hinge pin level.
 - 2. Lift Check Valve: With stem upright and plumb.

3.06 FIELD QUALITY CONTROL

- A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

3.07 ADJUSTING AND CLEANING

- A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.
- B. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

END OF SECTION 22 05 23

SECTION

HANGERS AND SUPPORTS FOR PLUMBING PIPING

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Horizontal-piping hangers and supports.
 - 2. Vertical-piping clamps.
 - 3. Saddles and Shields.
 - 4. Hanger-rod attachments.
 - 5. Building attachments.
 - 6. Spring hangers and supports.
 - 7. Pre-engineered support strut systems
 - 8. Pipe alignment guides.
 - 9. Anchors.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "Plumbing Insulation", for high density insulation for protecting insulation vapor barrier and materials and methods for piping hanger installations.
 - 2. Division 22 "Water Distribution Piping and Specialties", for pipe hanger types and spacing for horizontal and vertical domestic water distribution and heat traced piping of sizes and materials indicated.
 - 3. Division 22 "Sanitary Drainage & Vent Piping and Specialties", for pipe hanger types and spacing for heat traced and cold sanitary piping of sizes and materials indicated.
 - 4. Division 22 "Storm Drainage & Piping and Specialties", for pipe hanger types and spacing for horizontal and vertical storm drainage piping of sizes and materials indicated.

1.02 DEFINITIONS

- A. Terminology used in this Section is defined in MSS SP-90.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with conditions of contract and Division 01 specification Sections.
 - 1. Product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing Manufacturer's figure number, size, location, and features for each required pipe hanger and support.
 - 2. Product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.
 - 3. Welder certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.
 - 4. Assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.
 - 5. Maintenance data for supports and anchors for inclusion in Operating and Maintenance Manual specified in Division 01 and Division 22 Section "General Plumbing Requirements."
 - 6. Submit style and type of anchors to Architect or Structural Engineer for approval prior to installation.

1.04 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Qualify welding processes and welding operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
- C. Regulatory Requirements: Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.
- D. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Hangers, supports, and components shall be listed and labeled by a NRTL where used for fire protection piping systems. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Hangers and Supports
 1. Armacell.
 2. Anvil International.
 3. B-Line.
 4. Elite Components
 5. Halfen-DEHA.
 6. Hilti.
 7. ERICO\Michigan Hanger Co..
 8. Midwest.
 9. National Pipe Hanger Corporation.
 10. Power-Strut.
 11. Truscon.
 12. Unistrut.
- B. Pre-Insulated Supports:
 1. Calcium Silicate Shield Supports:
 - a. Cooper B-Line, Inc.
 - b. Buckaroos, Inc.
 2. Pre-Engineered Thermal Hanger Inserts:
 - a. Armacell "Armafix".
 - b. Cooper B-Line, Inc.
- C. Expansion Anchors:
 1. Hilti.
 2. Phillips.
 3. Power Fasteners.
 4. Rawl.
- D. Pre-Insulated Supports:
 1. Calcium Silicate Shield Supports:
 - a. Cooper B-Line, Inc.
 - b. Buckaroos, Inc.
 2. Pre-Engineered Thermal Hanger Inserts:
 - a. Armacell "Armafix".
 - b. Cooper B-Line, Inc.

2.02 SUPPORT MATERIALS

- A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.
 1. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.
 2. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
 3. Components as listed below shall be made of 304 stainless steel where indicated.

2.03 SHIELDS

- A. Pre-Insulated Supports:
 1. Calcium Silicate Shield Supports:
 - a. Waterproofed calcium silicate conforming to ASTM C795 encased with an insulation protection shield.
 2. Pre-Engineered Thermal Hanger Inserts:
 - a. Flexible elastomeric insulation conforming to ASTM C534, Type I with integral high density pipe support.
- B. Insulation Protection Shield:
 1. Sheet metal construction, meeting MSS SP-69 & SP-58 Type 40, of 18 gauge for 5-1/2" inside dimension and smaller, 16 gauge for 6-1/2" to 10-3/4" inside dimension 14 gauge for 11-3/4" to 17" inside dimension, and 12 gauge for 18" to 28" inside dimension. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
 - a. Length: Minimum 8 inch long section at each support joint.
 - b. For pipes 2 inch and smaller using fiberglass or flexible elastomeric insulation without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe Size (NPS)	Insulation Thickness (inches)	Minimum Shield Length, (in) Hanger Spacing, (ft)					
		5	6	7	8	9	10
≤ 1	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
	1.5	3	5	5	-	-	-
	2	3	3	3	-	-	-
	3	3	3	3	-	-	-
≤ 2	0.5	8	8	11	11	12	14
	1	5	6	8	9	11	11
	1.5	5	6	8	8	9	9
	2	5	5	6	6	8	8
	3	5	5	6	6	6	8

2. 360° Insulation Protection Shield: Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
- C. Hangers with pre-manufactured polymer inserts:
 1. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally may be used in lieu of other insulated pipe support systems. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Note: Metal shields are not required with clevis hangers of this type. Approved manufacturers include:
 - a. Kilo-Shure.
 - b. Anvil.

- c. Holdrite.

2.04 PRE-ENGINEERED SUPPORT STRUT SYSTEMS

- A. Support strut systems shall comply with MSS SP-69, Type 59. Shop- or field-fabricated pipe-support assembly shall be made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts. Minimum 14 gauge galvanized steel with factory-punched attachment holes. Two piece straps shall be captivated at the shoulder when attachment nut is tightened and designed for use with strut system. Long or short pipe rollers designed for use with strut system, where indicated, shall attach to the channel with brackets and nuts. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated. All nuts, brackets and clamps shall have the same finish as the channels.

2.05 PIPE ALIGNMENT GUIDES

- A. Factory fabricated, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

2.06 EXPANSION ANCHORS

- A. Self drilling, drilled flush or shell type.

2.07 MISCELLANEOUS MATERIALS

- A. Steel Plates, Shapes, and Bars: Conforming to ASTM A 36.
- B. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install hangers and supports in accordance with manufacturer's installation instructions.

3.02 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install hangers, supports, clamps and attachments to support piping properly from building structure.
- B. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.
- C. Hanger and clamps sizing:
1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
 2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter.
 3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.
 4. Refer to Section 220700 for definition of hot and cold piping and required insulation thickness.
- D. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacing complying with MSS SP-69. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
- E. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert

to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.
- G. Field-Fabricated, Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS D-1.1.
- H. Support fire protection systems piping independently from other piping systems.
- I. Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
- J. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.
- L. Insulated Piping: Comply with the following installation requirements.
 - 1. Riser Clamps: Attach riser clamps, including spacers (if any), to piping with riser clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 22 Section "Plumbing Insulation".
 - 2. Pipe Covering Protection Saddles: Install pipe covering protection saddles where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
 - 3. Insulation Protection Shield: Install insulation protection shield and high density insulation where vapor barrier is indicated, sized for the insulation thickness used as specified in Division 22 Section "Plumbing Insulation".
 - a. Exception for horizontal cold piping with fiberglass or flexible elastomeric insulation 2 inch and smaller: Rest fiberglass insulated pipe on hanger shield with length specified for pipe size and insulation thickness to prevent puncture or other damage as specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
 - 4. Contractor's Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inch and larger.
 - 5. Contractor's Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.
- M. Pre-engineered Support Strut Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer's recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.
 - 1. Uninsulated Copper Pipe: Install with plastic galvanic isolators
 - 2. Insulated Tube or Pipe: Install with 360° insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 22 Section "Plumbing Insulation".
- N. Expansion Anchors: Use in existing concrete, masonry or in pre-cast concrete construction.

3.03 INSTALLATION OF PIPE ALIGNMENT GUIDES

- A. Install pipe alignment guides on piping that adjoins expansion joints, as required by expansion joint manufacturer, and elsewhere as indicated on plans and specification sections to eliminate binding and torsional stress on piping systems. Install guides per ASME B31.9 unless noted otherwise.
- B. Anchor to building substrate.

3.04 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to control movement to compensators.
- D. Anchor Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.05 EQUIPMENT SUPPORTS

- A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
- B. Grouting: Place grout under supports for piping and equipment.

3.06 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.07 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Touch-Up Painting: Cleaning and touch-up painting of field welds, bolted connections, and abraded areas of the shop paint on miscellaneous metal is specified in Division 9 Section "Painting".
- C. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 22 05 29

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. Extent of Plumbing work to be identified as required by this Section is indicated on drawings and/or specified in other Division 22 Sections.
- B. Types of identification devices specified in this Section include the following:
 - 1. Plastic Pipe Markers
 - 2. Plastic Tape
 - 3. Valve Tags
 - 4. Valve Schedule Frames
 - 5. Engraved Plastic-Laminate Signs
 - 6. Plastic Equipment Markers
 - 7. Plasticized Tags

1.02 CODES AND STANDARDS:

- A. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.
- C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.
- D. Maintenance Data: Include product data and schedules in Maintenance Manuals as specified in Division 1 and Section "General Plumbing Requirements."

1.04 SPARE PARTS

- A. Furnish minimum of 5% extra stock of each plumbing identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.
 - 1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

PART 2 - PRODUCTS AND MATERIALS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide plumbing identification materials of one of the following:
 - 1. Allen Systems, Inc.
 - 2. Brady (W.H.) Co.; Signmark Div.

3. Industrial Safety Supply Co., Inc.
4. Seton Name Plate Corp.

2.02 PLUMBING IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.03 PLASTIC PIPE MARKERS

- A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1
- B. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1
- C. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F (52 degrees C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
- D. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 2. Adhesive lap joint in pipe marker overlap.
 3. Laminated or bonded application of pipe marker to pipe (or insulation).
 4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".
- E. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
 1. Laminated or bonded application of pipe marker to pipe (or insulation).
 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
 3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.
- F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.
- G. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with names as shown or specified.

2.04 PLASTIC TAPE

- A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
- B. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2-1/2" wide tape for larger pipes.
- C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.05 VALVE TAGS

- A. Brass Valve Tags: Provide 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.
 1. Provide 1-1/2" diameter tags, except as otherwise indicated.
 2. Fill tag engraving with black enamel.

- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- C. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

2.06 VALVE SCHEDULE FRAMES

- A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.07 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with ASTM D 709, in the sizes and thickness indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for plumbing fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8" for larger units.
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.08 PLASTIC EQUIPMENT MARKERS

- A. General: Provide manufacturer's standard laminated plastic, color coded equipment markers. Conform to the following color code:
 - 1. Green: Cooling equipment and components.
 - 2. Yellow: Heating equipment and components.
 - 3. Yellow/Green: Combination cooling and heating equipment and components.
 - 4. Brown: Energy reclamation equipment and components.
 - 5. Blue: Equipment and components that do not meet any of the above criteria.
 - 6. For hazardous equipment, provide colors and designs recommended by ANSI A13.1.
- B. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
 - 1. Name and plan number.
 - 2. Equipment service.
 - 3. Design capacity.
 - 4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.
- C. Size: Provide 2-1/2" x 4" markers for control devices, dampers, and valves; and 4-1/2" x 6" for equipment.

2.09 PLASTICIZED TAGS

- A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing. Tags shall be minimum 3-1/4" x 5-5/8" in size, provided with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.10 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.

1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished plumbing spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.02 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
 1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
- B. Application: Provide piping system identification for the following systems:
 1. Domestic cold water piping.
 2. Domestic hot water piping.
 3. Domestic hot water recirculating piping.
 4. Sanitary and waste piping.
 5. Storm water piping.
 6. Vent piping.
 7. Insulated and non-insulated storm water piping.
 8. Compressed air piping.
 9. Medical gas piping (indicate each type of system, accordingly).
- C. Location: Install pipe markers and color bands in the following locations where piping is exposed to view, concealed only by a removable ceiling system, installed in machine rooms, installed in accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
 1. Within 5 feet of each valve and control device.
 2. Within 5 feet of each branch, excluding take-offs less than 25 feet in length for fixtures; mark flow direction of each pipe at branch connection.
 3. Within 5 feet where pipes pass through walls, floors or ceilings or enter non-accessible enclosures. Provide identification on each side of wall, floor or ceiling.
 4. At access doors, manholes and similar access points which permit view of concealed piping.
 5. Within 5 feet of major equipment items and other points of origination and termination.
 6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment where there are more than two piping systems or pieces of equipment.

3.03 VALVE IDENTIFICATION

- A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibbs, and shut-off valves at plumbing fixtures and similar rough-in connections of end-use fixtures and units.

- B. List each tagged valve in valve schedule for each piping system. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.
 - 1. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

3.04 PLUMBING EQUIPMENT IDENTIFICATION

- A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of plumbing equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 - 1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - 2. Meters, gauges, thermometers and similar units.
 - 3. Pumps
 - 4. Heat exchangers
 - 5. Water heaters, tanks and pressure vessels.
 - 6. Strainers, water treatment systems and similar equipment.
- B. Optional Sign Types: Where lettering larger than 1" height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.
- C. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 2'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering.
- D. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
 - 1. Optional Use of Plasticized Tags: At Installer's option, where equipment to be identified is concealed above acoustical ceilings or similar concealment, plasticized tags may be installed within concealed space to reduce amount of text in exposed sign (outside concealment).
 - 2. Operational valves and similar minor equipment items located in non-occupied spaces (including machine rooms) may, at Installer's option, be identified by installation of plasticized tags in lieu of engraved plastic signs.

END OF SECTION 22 05 53

SECTION 22 07 00 PLUMBING INSULATION

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. Extent of Plumbing insulation required by this Section is indicated on drawings and schedules, and by requirements of this Section.
- B. Types of Plumbing insulation specified in this Section include the following:
 - 1. Piping Systems Insulation:
 - a. Fiberglass
 - b. Flexible Elastomeric
 - 2. Equipment Insulation:
 - a. Fiberglass
 - b. Flexible Elastomeric

1.02 QUALITY ASSURANCE

- A. Flame/Smoke Ratings: Provide composite Plumbing insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E 84 (NFPA 255) method.
 - 1. Exception: Outdoor Plumbing insulation may have flame spread index of 75 and smoke developed index of 150.
 - 2. Exception: Industrial Plumbing insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields for protecting insulation vapor barrier and materials and methods for piping installations.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of Plumbing insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each Plumbing system requiring insulation.
- B. Maintenance Data: Submit maintenance data and replacement material lists for each type of Plumbing insulation. Include this data and product data in maintenance manual.

PART 2 - PRODUCTS AND MATERIALS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
 - 1. Aeroflex USA, Inc.
 - 2. Armacell LLC.
 - 3. CertainTeed Corp.
 - 4. Knauf Insulation
 - 5. Johns Manville
 - 6. K-Flex USA
 - 7. Owens Corning

2.02 PIPING INSULATION MATERIALS

- A. Fiberglass Piping Insulation: ASTM C 547, Class 1 unless otherwise indicated.
- B. Flexible Elastomeric Piping Insulation: ASTM C534, Type I.
- C. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.
- D. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.
- E. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.
- F. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.
- G. High Density Insulation Billets:
 - 1. Calcium Silicate: ASTM C533 and C795.

2.03 EQUIPMENT INSULATION MATERIALS

- A. Rigid Fiberglass Equipment Insulation: ASTM C612, Class 2.
- B. Flexible Fiberglass Equipment Insulation: ASTM C553, Type I, Class B-4.
- C. Flexible Elastomeric Equipment Insulation: ASTM C534, TYPE II.
- D. Jacketing Material for Equipment Insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or metal jacket at Installer's option, except as otherwise indicated.
- E. Equipment Insulation Compounds: Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.
- F. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's installation instructions.

3.02 PLUMBING PIPING SYSTEM INSULATION

- A. Insulation Omitted: Omit insulation on the following:
 - 1. Chrome-plated exposed piping
 - 2. Water Hammer Arrestors
 - 3. Balancing and flow valves
 - 4. Drain lines from water coolers
 - 5. Exterior condensate drain piping
 - 6. Pre-insulated equipment.
- B. Cold Piping:
 - 1. Application Requirements: Insulate the following cold plumbing piping systems:
 - a. Potable cold water piping.
 - b. Non-potable cold water piping
 - c. Potable chilled water piping.
 - d. Plumbing vents within 6 lineal feet of roof outlet.
 - e. Horizontal and vertical interior above-ground storm drainage piping and vertical run from roof drain to horizontal run.

- f. Horizontal and vertical interior above-ground overflow storm drainage piping and vertical run from roof drain to horizontal run. Where vertical overflow storm drainage piping from the outlet exceeds 15 feet, only insulate within 15 feet of the outlet.
 - g. Condensate piping inside the building.
 - 2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
 - a. Fiberglass: 1" thickness.
 - C. Hot Piping:
 - 1. Application Requirements: Insulate the following hot plumbing piping systems:
 - a. Potable hot water piping.
 - b. Potable hot water recirculation piping.
 - c. Hot drain piping (where indicated).
 - 2. Insulate hot water piping systems up to 140F specified above with one of the following types and thicknesses of insulation:
 - a. Fiberglass: 1" thick for pipe sizes up to and including 1-1/4", 1-1/2" thick for pipe sizes 1-1/2" and larger.
 - D. P-traps:
 - 1. Insulate P-traps receiving chilled water waste and P-traps of water coolers as described below:
 - a. Flexible Elastomeric: 1/2" thick for pipe sizes up to and including 2", 1" thick for pipe sizes 2" to 6" (largest size permitted).
 - 2. Insulate P-traps receiving hot water waste above 140F as described below:
 - a. Fiberglass: 1" thickness.
 - b. Flexible Elastomeric (high temp formula up to 300F): 1" thickness.

3.03 EQUIPMENT INSULATION

- A. Cold Equipment (Below Ambient Temperature):
 - 1. Application Requirements: Insulate the following cold equipment:
 - a. Drip pans under chilled equipment.
 - b. Roof drain bodies.
 - 2. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:
 - a. Fiberglass: 2" thick for cold surfaces above 35 degrees F (2 degrees C) and 3" thick for surfaces 35 degrees F (2 degrees C) and lower.

3.04 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Maintain continuous thermal and vapor-retarder integrity throughout entire installation unless otherwise indicated.
- C. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- D. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- E. Clean and dry pipe surfaces prior to insulating.

- F. Provide high density insulation material under supports or pre-insulated supports for cold piping. Protect insulation with shields to prevent puncture or other damage. Refer to Division 22 Section "Hangers and Supports for Plumbing Piping" for pre-insulated supports and insulation shields.
 - 1. Insulation material shall extend a minimum 2 inches past the pipe shield on each side.
- G. Provide pipe hangers for hot piping sized for the outside diameter of piping. Butt insulation to hanger or riser clamp for vertical pipe. Butt pipe insulation tightly at insulation joints. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.
- H. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves (except balancing and flow control valves), strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Butt tightly against adjoining pieces and bond with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 - 8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves (except balancing and flow control valves), flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 - 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- I. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

- J. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 - 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 - 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
- K. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

3.05 INSTALLATION OF EQUIPMENT INSULATION

- A. General: Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.
- B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.
- C. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.
- D. Do not apply insulation to equipment, breechings, or stacks while hot.
- E. Apply insulation using the staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.
- F. Coat insulated surfaces with layer of insulating cement, troweled in workmanlike manner, leaving a smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
- G. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2". Apply over vapor barrier where applicable.
- H. Do not insulate boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.
- I. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

3.06 EXISTING INSULATION REPAIR

- A. Repair damaged sections of existing Plumbing insulation, both previously damaged or damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.07 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 22 07 00

SECTION 22 11 00 WATER DISTRIBUTION PIPING AND SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes domestic cold water, hot water, and hot water recirculation piping, fittings, and specialties within the building to a point 5 feet outside the building.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
 - 2. Division 22 Section "Identification, for Plumbing Piping and Equipment" for labeling and identification of water distribution piping.
 - 3. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall penetrations and equipment pads.
 - 4. Division 22 Section "Basic Piping Material and Methods," for materials and methods for strainers, flexible connectors, unions, dielectric unions, dielectric flanges and mechanical sleeve seals.
 - 5. Division 22 Section "General Duty Valves for Plumbing Piping," for materials and methods for installing water distribution piping valves.
 - 6. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields, materials and methods for hanging and supporting water distribution piping.
 - 7. Division 22 Section "Plumbing Insulation," for materials and methods for insulating water distribution piping.
 - 8. Division 22 Section "Sanitary Drainage and Vent Piping and Specialties," for material and methods for trap primer outlet piping.

1.02 DEFINITIONS

- A. Water Distribution Pipe: A pipe within the building or on the premises that conveys water from the water service pipe or meter to the points of usage.
- B. Water Service Pipe: The pipe from the water main or other source of potable water supply to the water distribution pipe of the building served.
- C. Pipe sizes used in this Specification are nominal pipe size (NPS).
- D. 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 Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.
 - 1. Product data for each piping specialty and valve specified.
 - 2. Welder Certificates signed by Contractor certifying that welders comply with requirements specified in Article "Quality Assurance" below.
 - 3. Certification of Compliance with ASME and UL fabrication requirements specified in Article "Quality Assurance" below.
 - 4. Maintenance data for each piping specialty and valve specified for inclusion in Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."
 - 5. Test reports specified in Part 3 of this Section.

6. Submit certification that specialties and fittings for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372. The following specialties need not comply:
 - a. Wall, yard and roof hydrants
 - b. Emergency mixing valves

1.04 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."
- B. Regulatory Requirements: Comply with the provisions of the following codes:
 1. ASME B31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
 2. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications" for Qualifications for Welding Processes and Operators.
- C. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.
- D. Pipe, fittings and specialties shall be manufactured in the United States or be certified to meet ASTM and ANSI standards.

1.05 SPARE PARTS

- A. Maintenance Stock: Furnish one valve key for each key-operated wall hydrant, hose bibb, fixture supply, or faucet installed.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Automatic Flow Control Valves:
 - a. Flow Design, Inc., Autoflow Div
 - b. Victaulic Company
 - c. Calefi
 2. Wall/Yard Hydrants:
 - a. Josam Co.
 - b. Smith (Jay R.) Mfg. Co.
 - c. Prier, Inc.
 - d. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
 - e. Watts Drainage
 - f. Woodford Mfg. Co.
 - g. Zurn Industries Inc., Hydromechanics Div.
 3. Backflow Preventers:
 - a. Cla-Val Co.
 - b. Conbraco Industries, Inc.
 - c. Febco
 - d. Hersey Products, Inc.
 - e. Watts Regulator Co.
 - f. Zurn Industries Inc. Wilkins Regulator Div.

4. Piston Type Water Hammer Arresters:
 - a. Amtrol, Inc.
 - b. Josam Co.
 - c. Precision Plumbing Products, Inc.
 - d. PROFLO
 - e. Sioux Chief Manufacturing Co.
 - f. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
 - g. Watts Regulator Co.
 - h. Zurn Industries, Inc. Wilkins Regulator Div.
5. Point of Use Thermostatic Mixing Valves
 - a. Acorn Engineering Co.
 - b. Cash Acme
 - c. Leonard Valve Co.
 - d. Powers Process Controls
6. Emergency Mixing Valves
 - a. Acorn Engineering Co.
 - b. Bradley
 - c. Haws Corp.
 - d. Lawler Manufacturing Co., Inc.
 - e. Leonard Valve Co.
 - f. Stingray Systems
7. Trap Primers and Distribution Units
 - a. PROFLO
8. Plumbing Pipe Support Brackets
 - a. PROFLO
9. Tube Suspension Clamps
 - a. PROFLO
10. Roof Hydrants
 - a. Mapa
 - b. Woodford Mfg. Co.
 - c. Prier, Inc.

2.02 PIPE AND TUBE MATERIALS, GENERAL

- A. Pipe and Tube: Refer to Part 3, Articles "Above Ground Water Distribution Pipe and Fittings" or "Below Ground Water Distribution Pipe and Fittings", for identification of systems where the materials listed below are used.
- B. Copper Tube: ASTM B88, Type L Water Tube, drawn temper.
- C. Copper Tube: ASTM B88, Type K Water Tube, annealed temper.
- D. Brass Pipe: Chrome Plated Schedule 40 ASTM B43 iron pipe size (IPS.)

2.03 FITTINGS

- A. Wrought Copper Solder-Joint Fittings: ANSI B16.22, streamlined pattern.
- B. Brass Fittings: Chrome plated ANSI B16, Class 125 with threaded connections.
- C. Bronze Flanges: ANSI B16.24, Class 150, raised ground face, bolt holes spot faced.
- D.

2.04 JOINING MATERIALS

- A. Solder Filler Metal: ASTM B32 Alloy Sb-5, 95-5 Tin-Antimony.
- B. Brazing Filler Metals: AWS A5.8, BAg Silver.

2.05 GENERAL-DUTY VALVES

- A. General-duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division 22 Section "General Duty Valves for Plumbing Piping." Special duty valves are specified below by their generic name; refer to Part 3, Article "Valve Applications" for specific uses and applications for each valve specified.

2.06 SPECIAL DUTY VALVES

- A. Automatic Flow Control Valves: 400 PSI WOG, flow regulator, with series 300 stainless steel body, series 300 stainless steel automatic pre-set flow balancing cartridge, union connection body, and threaded-end connections.

2.07 PIPING SPECIALTIES

- A. Recessed Nonfreeze Wall Hydrants: Cast-bronze box, with chrome-plated face, tee handle key, vacuum breaker, hinged locking cover, 3/4-inch inlet, and hose outlet. Bronze casing shall be length to suit wall thickness.
- B. Roof Hydrants: As specified on the drawings.
- C. Backflow Preventers: Comply with requirements of ASSE Standard 1013 and as specified on the drawings.
- D. Piston Type Water Hammer Arresters: Piston type, with casing of type "L" copper tube and spun copper ends, nylon piston with two EPDM "O" rings pressure lubricated with FDA approved silicone, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201.
- E. Point of Use Thermostatic Mixing Valves:
 - 1. Lead free bronze or brass body meeting ASTM B584 with non-corrosive parts, tamper resistant temperature adjustment, checks, stops, other components as scheduled and meeting ASSE 1070. Valve shall be designed to fail to the cold side of the system. Maximum pressure drop shall not be exceeded for the scheduled flow rate.
- F. Emergency Mixing Valves:
 - 1. Bronze body construction meeting ASTM B584, non-corrosive parts, tamper resistant temperature adjustment, union inlets. Valve shall be designed to fail to the cold side of the system with full cold water flow. Maximum pressure drop shall not be exceeded for the scheduled flow rate.
- G. Trap Primers: Brass construction, line pressure operation, capacity to prime number of traps as indicated with distribution units complying with requirements of ASSE Standard 1018.
- H. Pipe Support Brackets:
 - 1. Sheet Stud Bracket: 20 gauge copper with nominal copper tube holes of 1/2" on 2" centers and holes of 3/4" or 1" on 4" centers.
 - 2. Pipe Mounted Bracket: 20 gauge copper or plastic bracket with clamps for securing copper water tube and stainless steel hose clamp for securing bracket to vertical waste and vent pipe in wall.
 - 3. Carrier Bracket: 20 gauge copper bracket with 1" hole for supporting rough-in for flush valve copper tube and bolt slot for attaching to chair carrier.
- I. Tube Suspension Clamps
 - 1. Combination plastic supports and insulators for installing copper tube in stud walls with integral bracket for securing to stud with screws.

PART 3 - EXECUTION

1.1 INSTALLATION, GENERAL

- A. Install piping, valves and specialties in accordance with manufacturer's installation instructions.

3.02 ABOVE GROUND WATER DISTRIBUTION PIPE AND FITTINGS

- A. Install Type L, drawn copper tube with wrought copper fittings and solder joints for pipe sizes 8 inches and smaller, within the building.
- B. Install chrome plated brass pipe and fittings for exposed water piping within the building where indicated on the drawings.

3.03 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and branch connections.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap.
- I. Fire Barrier Penetrations: Where pipes pass through fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.
- J. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Basic Piping Materials and Methods" for special sealers and materials.
- K. Install piping level with no pitch.

3.04 HANGERS AND SUPPORTS

- A. General: Hanger, support, insulation protection shield and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.
- B. Pipe Attachments: Install the following:
 - 1. Adjustable steel clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
 - 2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs. Provide copper coated riser clamps when in contact with copper tube.
 - 3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Supports and Anchors" and "Plumbing Insulation".

4. Copper coated extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of copper tube 2" and smaller on walls and for securing 1-1/4" to 2" copper tube inside walls and chases for battery fixtures. Secure clamp to the copper tube.
 - a. Seal each joint with insulation and split ring pipe to maintain the insulation barrier. Refer to Section "Mechanical Insulation" for requirement for maintenance of the vapor barrier and vapor barrier seal method.
 5. Extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of stainless steel tube 2" and smaller on walls or for securing tube inside walls for connection to faucets.
 6. Support copper tube in chases and walls at plumbing fixtures with plastic or copper brackets secured to structure and U-bolts sized to bare on the pipe.
 7. Engineered strut support system may be provided, at the contractor's option, in lieu of individual hangers for horizontal pipes as specified in Division 22 "Hangers and Supports for Plumbing Piping". Provide two piece straps for uninsulated pipe secured to the bare pipe and provide plastic galvanic isolators for bare copper tube. Provide two piece straps and 360° insulation protection shields sized for the insulation thickness used for the pipe for all insulated pipes.
 8. Secure copper tube rough-in for individual fixtures with sheet stud brackets attached to the wall studs or pipe mounting brackets attached to the fixture waste & vent pipe at each plumbing fixture.
 9. Secure 1" and smaller copper water tubing in stud walls at stud penetrations with tube suspension clamps.
 - a. Cut hole through non-supporting studs with a minimum 1/8" clearance around each uninsulated copper tube or insulated copper tube.
 - b. Seal each joint of insulation and tube suspension clamp to maintain the insulation barrier. Refer to Division 22 "Plumbing Insulation" for requirement for maintenance of the vapor barrier similar to insulation butted against insulation inserts and vapor barrier seal method.
 10. Secure copper tubes for flush valve wall mounted water closets to the chair carrier with carrier brackets.
- C. Install hangers for horizontal piping with the following maximum spacing and minimum rod sizes:

<u>Nom. Pipe Size - In.</u>	<u>Steel Pipe Max. Span - Ft.</u>	<u>Copper Tube Max. Span - Ft.</u>	<u>Min. Rod Dia. - In.</u>
Up to 3/4	7	5	3/8
1	7	6	3/8
1-1/4	7	7	3/8
1-1/2	9	8	3/8
2	10	8	3/8
2-1/2	11	9	1/2
3	12	10	1/2
3-1/2	13	11	1/2
4	14	12	5/8 (1/2 for copper)
5	16	13	5/8 (1/2 for copper)
6	17	14	3/4 (5/8 for copper)

1. Support vertical copper tube at each floor and in intervals not to exceed 10 feet.
- D. Support water piping within 12" of each elbow or tee and for water piping 2-1/2" and larger at each valve or strainer.

- E. Support water piping above the floor with pipe supports attached to the floor with anchor bolts where indicated on the drawings. Conform to the table above for maximum spacing of supports.

3.05 PIPE AND TUBE JOINT CONSTRUCTION

- A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
- B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
 - 1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts of piping specialties before soldering and brazing.
 - 2. Fill the tubing and fittings during brazing with an inert gas (nitrogen or carbon dioxide) to prevent formation of scale.
 - 3. Heat joints to proper and uniform temperature.
- C. Threaded Joints: Conform to ASME B1.20.1, tapered pipe threads for field-cut threads. Join pipe fittings and valves as follows:
 - 1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - 2. Align threads at point of assembly.
 - 3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
 - 4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
 - a. Damaged Threads: Do not use pipe with corroded or damaged threads. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- D. Joints Containing Dissimilar Metals: Provide dielectric unions for 2" and smaller and dielectric flanges for piping 2-1/2" and larger. Provide dielectric waterway fittings for 2" and smaller in concealed locations. Dielectric unions, waterway fittings and flanges are specified in Section "Basic Piping Materials and Methods".
- E. Joints at Valve Assemblies or Connections to Equipment: Provide unions downstream of shutoff valves at valve assemblies or equipment connections. Unions are not required at flanged connections. Unions are specified in Division 22 section "Basic Piping Materials and Methods".

3.06 VALVE APPLICATIONS

- A. General-Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shut-off duty: Use gate, ball, and butterfly valves.
- B. Throttling duty: Use globe, ball, and butterfly valves.

3.07 INSTALLATION OF VALVES

- A. Sectional Valves: Install sectional valves on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures or equipment connections, and elsewhere as indicated. For sectional valves 2 inches and smaller, use gate or ball valves; for sectional valves 2-1/2 inches and larger, use ball, gate or butterfly valves.
- B. Shutoff Valves: Install shutoff valves on inlet of each plumbing equipment item, on each supply to each plumbing fixture, and elsewhere as indicated. For shutoff valves 2 inches and smaller, use gate or ball valves; for shutoff valves 2-1/2 inches and larger, use ball, gate or butterfly valves.
- C. Drain Valves: Install drain valves on each plumbing equipment item, located to drain equipment completely for service or repair. Install drain valves at the base of each riser, at low points of horizontal runs, and elsewhere as required to drain distribution piping system completely. For drain valves 2 inches and smaller, use gate or ball valves; for drain valves 2-1/2 inches and larger, use ball, gate or butterfly valves.
- D. Check Valves: Install swing check valves on discharge side of each pump and elsewhere as indicated.

- E. Emergency Mixing Valves: Install where indicated on the plans with hot and cold water branch lines connecting to the mains without any shutoff valves. No other fixtures shall connect to the branch lines feeding the emergency mixing valve. Install ball valves with locking handles at the emergency mixing valve as indicated on the plans.
- F. Point-of-Use Thermostatic Mixing Valve: Install valve complying with ASSE 1070 on all public lavatories and handwashing sink locations. Install valve to be accessible by maintenance staff. Set temperature limit to 110F for dual temperature faucet or 100F for single temperature faucet."

3.08 INSTALLATION OF FLOW CONTROL VALVES

- A. Install flow control valves or automatic flow control valves in each hot water recirculating loop, and elsewhere as indicated. Install a shutoff valve and strainer upstream and a union, check valve and shutoff valve downstream of each flow control or automatic flow control valve.
- B. Set flow control valve flow rate as follows:
 - 1. Preliminary Procedures For Hot Water Return System Balancing:
 - a. Before operating the system perform these steps:
 - 1) Open valves at recirculation pump and flow control valves to full open position.
 - 2) Remove and clean all strainers.
 - 3) Check recirculation pump rotation.
 - 4) Set water heater temperature as indicated on the drawings.
 - 2. Procedures For Hot Water Return System Balancing
 - a. Refer to the drawings for required flow rate for each flow control valve.
 - b. Provide required instrumentation to obtain proper measurements. Instruments shall be properly maintained and protected against damage.
 - c. Apply instrument as recommended by the manufacturer.
 - d. Take readings with the eye at the level of the indicated value to prevent parallax.
 - e. Mark flow control valve setting with memory stop. Mark with paint or other suitable, permanent identification materials.
 - f. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.
- C. Reports: Prepare hot water return system balancing reports signed and submit to the Architect upon completion of the project. Include the following information:
 - a. Valve tag number and description of location
 - b. Valve body size
 - c. Differential pressure reading from instrument in psi
 - d. Actual flow rate derived from the manufacturer's charts and tables for the valve size and measured differential pressure.

3.09 TRAP PRIMERS

- A. Install trap primers where indicated and where required by local authorities having jurisdiction.
- B. Connect trap primer supply line to the top of domestic cold water line no larger than 1 1/2" in diameter.
- C. Provide trap primer distribution units for trap primers serving more than one trap.
- D. Install trap primer distribution level to insure even water distribution unit to each circuit.
- E. Where applicable, adjust the trap primer for proper flow.
- F. Install trap primers a minimum of 12 inches above finished floor for every 20 feet of horizontal outlet piping to floor drains served.
- G. Install trap primers in an accessible location.

- H. Refer to Division 22 Section "Sanitary Drainage and Vent Piping and Specialties" for trap primer outlet pipe requirements.

3.10 INSTALLATION OF PIPING SPECIALTIES

- A. Install backflow preventers at each connection to mechanical equipment and systems and in compliance with the plumbing code and authority having jurisdiction. Locate in same room as equipment being connected. Install air gap fitting and pipe relief outlet drain without valves to nearest floor drain.
- B. Install pressure reducing valves with inlet and outlet shutoff valves and balance cock bypass. Install pressure gauge on valve outlet.

3.11 EQUIPMENT CONNECTIONS

- A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by plumbing code.
- B. Mechanical Equipment Connections: Connect hot and cold water piping system to mechanical equipment as indicated. Provide shutoff valve and union for each connection; provide drain valve on drain connection. For connections 2-1/2 inches and larger, use flanges instead of unions.

3.12 FIELD QUALITY CONTROL

- A. Inspections: Inspect water distribution piping as follows:
 - 1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.
 - 2. During the progress of the installation, notify the plumbing official having jurisdiction at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
 - a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed in after system is roughed in and prior to setting fixtures.
 - b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.
 - c. Reinspections: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.
 - d. Reports: Prepare inspection reports signed by the plumbing official and turn over to the Architect upon completion of the project.
- B. Piping System Test: Test water distribution systems in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:
 - 1. Test for leaks and defects all new water distribution piping systems and parts of existing systems that have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
 - 2. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
 - 3. Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 4. Repair all leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.
 - 5. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.13 ADJUSTING AND CLEANING

- A. Clean and disinfect water distribution piping as follows:
 - 1. Purge all new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired prior to use.
 - 2. Use the purging and disinfecting procedure proscribed by the authority having jurisdiction or, in case a method is not proscribed by that authority, the procedure described in either AWWA C651, or AWWA C652, or as described below:
 - a. Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet.
 - b. Fill the system or part thereof with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system or part thereof and allow to stand for 24 hours.
 - c. Drain the system or part thereof of the previous solution and refill with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for 3 hours.
 - d. Following the allowed standing time, flush the system with clean, potable water until chlorine residual is lowered to incoming city water level.
 - e. Submit water samples in sterile bottles to the authority having jurisdiction. Repeat the procedure if the biological examination made by the authority shows evidence of contamination.
 - 3. Reports: Prepare disinfection reports signed by the authority having jurisdiction and turn over to the Architect upon completion of the project.

3.14 COMMISSIONING

- A. Fill the system. Check compression tanks to determine that they are not air bound and that the system is completely full of water.
- B. Before operating the system, perform these steps:
 - 1. Close drain valve, hydrants, and hose bibbs.
 - 2. Open valves to full open position.
 - 3. Remove and clean strainers.
 - 4. Check pumps for proper direction of rotation. Correct improper wiring.
 - 5. Lubricate pump motors and bearings.

END OF SECTION 22 11 00

SECTION 22 13 00

SANITARY DRAINAGE AND VENT PIPING AND SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes building sanitary drainage and vent piping systems, including drains and drainage specialties.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
 - 2. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
 - 3. Division 22 Section "Plumbing Identification," for labeling and identification of drainage and vent piping.
 - 4. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall and floor penetrations and equipment pads
 - 5. Division 22 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.
 - 6. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting drainage and vent piping.
 - 7. Division 22 Section "Plumbing Insulation," for materials and methods for insulating drainage piping.
 - 8. Division 22 Section "Water Distribution Piping and Specialties," for material and methods for trap primers and trap primer inlet piping.

1.02 DEFINITIONS

- A. Sanitary Building Drain: That part of the lowest piping of a drainage system which receives the discharge from soil, waste and other drainage pipes inside the walls of the building and conveys it to the building sewer.
- B. Sanitary Building Sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.
- C. Drainage System: Includes all the piping within a public or private premises which conveys sewage or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.
- D. Vent System: A pipe or pipes installed to provide a flow of air to or from a drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.
- B. Product data for the following products:
 - 1. Drainage piping
 - 2. Drainage piping specialties
 - 3. Floor drains
 - 4. Trench drains
 - 5. Interceptors
 - 6. No-hub fitting restraints

C. Test reports specified in Part 3 of this Section.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following codes:
1. 2018 International Plumbing Code

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Drainage Piping Specialties, including cleanouts, floor drains:
 - a. Josam Mfg. Co.
 - b. Sioux Chief Manufacturing Co. Inc.
 - c. Jay R. Smith Mfg. Co.
 - d. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
 - e. Watts Industries, Inc.
 - f. Zurn Industries, Inc.; Hydromechanics Div.
 2. Heavy Duty Hubless Couplings
 - a. Anaco Husky HD-2000
 - b. Clamp-All 80in. lb.
 - c. Ideal Tridon "HD"
 - d. ProFlo "HD"
 - e. Mission Rubber Company, "Heavy Weight"
 3. Cast Iron Soil Pipe and Fittings
 - a. AB & I Foundry
 - b. Charlotte Pipe and Foundry Company
 - c. Tyler Pipe / Soil Pipe Division
 4. Shielded Transition Couplings
 - a. FERNCO, "Proflex 3000 Series"
 - b. Mission Rubber Company, "Band Seal Specialty Couplings"
 5. Trap Seals
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB
 - c. Proset Systems "Trap Guard"
 - d. Sure Seal, Inc.
 - e. Zurn Industries, Inc.; Hydromechanics Div.
 6. Hubless Couplings:
 - a. Anaco
 - b. Ideal Tridon
 - c. Mission Rubber Company
 - d. ProFlo "PFNH"
 - e. Tyler Pipe / Soil Pipe Division
 7. No-Hub Fitting Restraints
 - a. Holdrite

2.02 ABOVE GROUND DRAINAGE AND VENT PIPE AND FITTINGS

- A. Cast-Iron Soil Pipe: CISPI 301 and ASTM A888, no-hub pipe and fittings and bearing the trademark of CISPI and NSF.
 - 1. Couplings and compression gaskets, NSF certified: ASTM C564 and CISPI 310.
 - 2. Heavy duty couplings and compression gaskets: ASTM C1540 and meeting FM 1680.
- B. Copper Tube: ASTM B306, Type DWV, hard drawn for pipe, and cast copper alloy solder joint drainage fittings (DWV) meeting ASME / ANSI B16.23.
 - 1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.
- C. Copper Tube: ASTM B88, Type M, hard drawn for pipe and wrought copper fittings with soldered joints.
 - 1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.
- D. Shielded Transition Couplings: ASTM C1460 with neoprene adapter gasket with stainless steel Shield and hose clamps.

2.03 DRAINAGE PIPING SPECIALTIES

- A. Cleanout Plugs: As specified on the drawings.
 - a. Floor Cleanouts: As specified on the drawings.
- B. Wall Cleanouts: As specified on the drawings.
- C. Floor Drains: As specified on the drawings.
- D. Trap seals: Provide trap seals meeting either description below:
 - 1. Smooth, soft, flexible, elastomeric PVC material molded into shape of duck's bill, open on top with curl closure at bottom. The flow of wastewater allows duck's bill to open and adequately discharge to floor drain through its interior. The duck's bill closes and returns to original molded shape after wastewater discharge is complete. Or, smooth, soft, flexible, elastomeric PVC material with a flapper closure. The flow of wastewater allows flapper to open and adequately discharge to floor drain through its interior. The flapper closes and returns to original molded shape after wastewater discharge is complete.
 - 2. Smooth, soft, flexible, elastomeric PVC material with a flapper closure. The flow of wastewater allows flapper to open and adequately discharge to floor drain through its opening. The flapper closes and returns to original position after wastewater discharge is complete.

2.04 NO-HUB FITTING RESTRAINTS

- A. Pre-engineered kits of galvanized steel pipe straps with stainless steel band clamps and tee bolts, meeting requirements of the CISPI Installation Handbook.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install pipe and specialties in accordance with manufacturer's installation instructions.

3.02 PIPE APPLICATIONS - ABOVE GROUND, WITHIN BUILDING

- A. Install hubless, cast-iron soil pipe and fittings for 15" and smaller soil, waste, and vent pipe.
- B. Install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings, copper sweat X screwed with solder joints, for waste connections from urinals, lavatories, sinks, water coolers, and kitchen equipment to cast iron drainage piping.
- C. Install Type M copper tube with wrought copper fittings with solder joints, 1" and smaller, with 3/4" minimum size and install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings for 1-1/4" and larger for waste connections from kitchen equipment and terminate over floor receptors with air gap.
- D. Install 1/2" type L copper tube for trap primer outlet piping.

3.03 PIPE AND TUBE JOINT CONSTRUCTION

- A. Copper Tubing: Solder joints in accordance with the procedures specified in AWS "Soldering Manual."
- B. Cast-Iron Soil Pipe: Make hubless joints in accordance with the Cast-Iron Soil Pipe & Fittings Handbook, Chapter IV. Install Couplings as followings:
 - 1. Install hubless couplings complying with CISPI 310 on soil, waste and vent piping.
 - 2. Install heavy duty hubless couplings on soil or waste stacks, soil and waste piping connections to soil or waste stacks and all soil and waste piping 4" and larger.
 - 3. Install No-Hub fitting restraints on joints 5" and larger at:
 - a. Changes of direction from vertical to horizontal
 - b. 4" branch connections, including tees, wyes and wye combination fittings to soil and waste piping 5" and larger
 - c. Horizontal changes of direction 22-1/2 degrees and greater
- C. PVC DWV Pipe: Joining and installation of PVC drainage pipe and fittings shall conform to ASTM D2665.
- D. ABS to PVC Transition Joints: When joining ABS to PVC components (such as an ABS building drain to PVC sewer pipe) make joints using solvent cements conforming to ASTM D3138.
- E. Cast Iron to PVC Above Grade: Join cast iron to PVC with shielded transition couplings.
- F. Cast Iron to PVC Below Grade: Join cast iron to PVC with underground shielded adapter couplings.

3.04 INSTALLATION

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing, slope, expansion, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and all branch connections.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Paint exposed copper drain lines serving kitchen equipment with a minimum of two coats of chromium-base paint.
- H. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings and floors, maintain the fire rated integrity. Refer to Division 22 Section "Basic Piping Material and Methods" for special sealers and materials.
- I. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.
- J. Make changes in direction for drainage and vent piping using appropriate 45 degree wyes, combination wye and eighth bend, or long sweep, quarter, sixth, eighth, or sixteenth bends. Sanitary tees or quarter bends may be used on vertical stacks of drainage lines where the

change in direction of flow is from horizontal to vertical, except use long-turn pattern combination wye and eighth bends where two fixtures are installed back to back and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. Double wyes or double wye combinations shall not be used in the horizontal. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper sized standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

- K. Install drainage piping pitched down at a minimum slope of 1/4 inch per foot (2 percent) for piping 3 inch and smaller, and 1/8 inch per foot (1 percent) for piping 4 inch and larger. Install vent piping pitched to drain back by gravity to the sanitary drainage piping system.

3.05 HANGERS AND SUPPORTS

- A. General: Hanger, support, insulation protection shields, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.
- B. Install the following pipe attachments:
1. Adjustable clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
 2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.
 3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Hangers and Supports for Plumbing Piping" and "Plumbing Insulation".
 - a. Install high density insulation on insulated pipe.
- C. Install hangers at the following intervals and provide rods of diameter as listed below:

Nom. Pipe Size	Steel Pipe Max. Span	Copper Tube Max. Span.	Min. Rod Dia. - Inches Steel or Cast Iron	Min. Rod Dia. - Inches Copper or PVC
<u>In Inches</u>	<u>In Feet</u>	<u>In Feet</u>		
Up to 3/4	7	5	3/8	3/8
1	7	6	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	9	8	3/8	3/8
2	10	8	3/8	3/8
2-1/2	11	9	1/2	3/8
3	12	10	1/2	1/2
3-1/2	13	11	1/2	1/2
4	14	12	5/8	1/2
5	16	13	5/8	1/2
6	17	14	3/4	5/8
8	19	16	7/8	3/4
10	22	18	7/8	3/4
12	23	19	7/8	3/4

1. Support all sizes of service weight horizontal cast iron piping every five feet, except up to ten feet where ten foot sections are installed. Support all sizes of hubless horizontal cast iron piping every other joint, unless over four feet, then support each joint. Provide support adjacent to joint, not to exceed 18". Provide sway brace on horizontal piping at not more than 40' intervals to prevent horizontal movement. Provide support at each horizontal branch.
2. Support all sizes of vertical cast iron piping every ten feet.
3. Support piping within 12" of each elbow or tee.

4. Support each P-trap.
- D. Support condensate piping located on roof with pre-engineered roof supports, pre-engineered roof supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table above for maximum spacing of supports. Adjust pipe support to maintain minimum pipe slope.

3.06 INSTALLATION OF PIPING SPECIALTIES

- A. Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:
 1. as required by plumbing code;
 2. at each change in direction of piping greater than 45 degrees;
 3. at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping;
 4. at base of each vertical soil and waste stack.
- B. Cleanout Covers: Install floor and wall cleanout covers for concealed piping, types as indicated.
- C. Floor Cleanouts: Install in below floor building drain piping at minimum intervals of 50' for piping 4" and smaller and 75' for larger piping.
 1. Install floor cleanouts in waterproof floors with waterproof membrane securely flashed with cleanout body flashing clamp so that no leakage occurs between cleanout body and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

3.07 INSTALLATION OF FLOOR DRAINS, FLOOR SINKS AND FLOOR TROUGHS

- A. Install floor drains, floor sinks and floor troughs in locations indicated.
- B. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor. Set floor sinks and floor troughs flush with the level finish floor.
- C. Refer to architectural documents for floor slope requirements and set floor drain elevation to match. Where architectural documents do not indicate the requirements, set the floor drain elevation depressed below the finished slab elevation as listed below to provide proper slope to drain:

<u>DEPRESSION IN INCHES</u>	<u>RADIUS OF AREA DRAINED - FEET</u>
1/2	5
3/4	10
1	15
1-1/4	20
1-1/2	25

- D. Provide P-traps for drains connected to the sanitary sewer.
- E. Install floor drains, floor sinks and floor troughs in waterproof floors with waterproof membrane securely flashed with drain flashing clamp so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
- F. Position drains so that they are level, accessible and easy to maintain.

3.08 INSTALLATION OF TRAP PRIMERS

- A. Install trap primer outlet piping with 1/32" per foot slope towards drain trap where possible.
- B. Connect trap primer outlet piping only to factory installed taps on the drain body or P-trap assembly or provide an auxiliary inlet fitting with factory installed trap primer tap.
- C. Install trap primer outlet piping in elevated slabs or slabs on grade below concrete reinforcing bars. Wrap with 1/2" thick flexible unicellular insulation, attach to the reinforcing bars with plastic ties and spacers every five feet to eliminate galvanic corrosion. Refer to Division 22 Section "Plumbing Insulation" for flexible unicellular insulation.
- D. Where proper trap primer outlet piping slope can be maintained and the trap primer outlet line would not be subject to freezing, trap primer outlet lines may be installed as follows:
 1. Install below elevated floor slabs.

2. Install in the sub grade of slab on grade.
- E. Install sleeves and caulk at penetrations through building floor for watertight installation. In an elevated floor slab installation, bracket the piping to bottom of floor once the slab is poured.
- F. Refer to Division 22 Section "Water Distribution Piping and Specialties" for trap primer and trap primer inlet pipe requirements.

3.09 INSTALLATION TRAP SEALS:

- A. Install trap seals in accordance with manufacturer's written instructions and in locations indicated.
- B. Make watertight seal using an adhesive type caulk along bottom of trap seal, if required by the manufacturer.
- C. Employ a test plug for testing and remove before normal floor drain use. Clean inside of drain tailpiece and install trap seal after testing.
- D. Do not touch elastomeric plug or allow contact with primer or solvent cement.

3.10 CONNECTIONS

- A. Piping Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by the plumbing code.
- B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

3.11 FIELD QUALITY CONTROL

- A. Inspections
 1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.
 2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
 - a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
 - b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.
 - c. Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspected by the plumbing official.
 - d. Reports: Prepare inspection reports, signed by the plumbing official.
- B. Piping System Test Test drainage and vent system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:
 1. Test for leaks and defects all new drainage and vent piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
 2. Leave uncovered and unconcealed all new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.
 3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of plumbing drainage and venting systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.

4. Final Plumbing Test Procedure: After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas and water-tight. Tightly close all openings, initially except vents thru the roof, in the system and fill the system with smoke from one or more smoke machines designed for smoke testing of plumbing systems. When smoke appears at a vent thru the roof, seal the vent thru roof with a test plug. Pressurize the system with 1" water column of smoke for 15 minutes. Use a "U" tube or manometer inserted in the trap of a water closet to measure this pressure. Visually verify all joints for leaks.
5. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
6. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.12 ADJUSTING AND CLEANING

- A. Clean interior of piping system. Remove dirt and debris as work progresses.
- B. Clean drain strainers, domes, and traps. Remove dirt and debris.

3.13 PROTECTION

- A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

END OF SECTION 22 13 00

SECTION 22 14 00 STORM DRAINAGE PIPING AND SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes building storm drainage piping systems, including drains and drainage specialties.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
 - 2. Division 33 Section "Storm Systems," for storm drainage piping beginning from 5'-0" outside the building.
 - 3. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
 - 4. Division 22 Section "Identification for Plumbing Piping and Equipment," for labeling and identification of drainage piping.
 - 5. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall and floor penetrations and equipment pads
 - 6. Division 22 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.
 - 7. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting drainage piping.
 - 8. Division 22 Section "Plumbing Insulation," for materials and methods for insulating drainage piping.

1.02 DEFINITIONS

- A. Storm Building Drain: That part of the lowest piping of a drainage system which receives the discharge from storm drainage pipes inside the walls of the building and conveys it to the building sewer.
- B. Storm Building Sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer or private sewer or other point of disposal.
- C. Drainage System: Includes all the piping within a public or private premises which conveys storm water or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.
- B. Product data for the following products:
 - 1. Drainage piping
 - 2. Drainage piping specialties
 - 3. Area drains
 - 4. Roof drains
 - 5. No-hub fitting restraints
- C. Test reports specified in Part 3 of this Section.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following codes:

1. 2018 International Plumbing Code

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Drainage Piping Specialties, including backwater valves, expansion joints, cleanouts, area/roof drains, cast-iron trench drains and downspout nozzles:
 - a. Josam Mfg. Co.
 - b. Sioux Chief Manufacturing Co. Inc.
 - c. Smith (Jay R) Mfg. Co.
 - d. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
 - e. Watts Industries, Inc.
 - f. Zurn Industries, Inc.; Hydromechanics Div.
 2. Heavy Duty Hubless Couplings
 - a. Anaco Husky HD-2000
 - b. Clamp-All 80in. lb.
 - c. Ideal Tridon "HD"
 - d. Mission Rubber Company "Heavyweight"
 - e. ProFlo "HD"
 3. Cast Iron Soil Pipe and Fittings
 - a. AB & I Foundry
 - b. Charlotte Pipe and Foundry Company
 - c. Tyler Pipe / Soil Pipe Division
 4. Shielded Transition Couplings
 - a. FERNCO, "Proflex 3000 Series"
 - b. Mission Rubber Company, "Band Seal Specialty Couplings"
 5. Underground Shielded Adapter Couplings
 - a. FERNCO, "1056 Series with SR73 Shear Ring"
 - b. Mission Rubber Company, "MR56 Series"
 6. No-Hub Fitting Restraints
 - a. Holdrite
 7. PVC DWV Expansion Joints
 - a. Charlotte Pipe and Foundry Company #133
 - b. Spears Manufacturing Company #S119

2.02 ABOVE GROUND DRAINAGE PIPE AND FITTINGS

- A. Cast-Iron Soil Pipe: CISPI 301 and ASTM A888, hubless pipe and fittings, and bearing the trademark of CIPSI and NSF.
 1. Heavy duty couplings and compression gaskets: ASTM C1540 and meeting FM 1680.
- B. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with "solid wall" PVC meeting ASTM D1784 with cell class 12454-B.
 1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints. Fittings 16" and larger shall be fabricated type.
 2. Solvent: ASTM D2564.

- C. Shielded Transition Couplings: ASTM C1460 with neoprene adapter gasket with stainless steel Shield and hose clamps.

2.03 UNDERGROUND BUILDING DRAIN PIPE AND FITTINGS

- A. Cast-Iron Soil Pipe: ASTM A74, Service weight, hub-and-spigot soil pipe and fittings, and bearing the trademark of CIPSI and NSF. Pipe and fittings shall have a heavy coating of coal tar varnish or asphaltum on both inside and outside surfaces.
 - 1. Neoprene Compression Gaskets: ASTM C564.
- B. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with "solid wall" PVC meeting ASTM D1784 with cell class 12454-B.
 - 1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints.
 - 2. Solvent: ASTM D2564.
- C. Underground Shielded Adapter Couplings: ASTM C1173 with neoprene adapter gasket with stainless steel shield and stainless steel hose clamps.

2.04 DRAINAGE PIPING SPECIALTIES

- A. Expansion Joints: Cast-iron body with adjustable bronze sleeve, bronze bolts with wing nuts.
- B. Cleanout Plugs: As specified on the drawings.
 - a. Floor Cleanouts: As specified on the drawings.
- C. Wall Cleanouts: As specified on the drawings.
- D. Area drains: As specified on the drawings.
- E. Roof Drains: As specified on the drawings.
- F. PVC DWV Expansion Joints: Schedule 40 PVC DWV meeting ASTM D2665 with socket connections and telescoping expansion joint with EPDM O-ring seal.

2.05 NO-HUB FITTING RESTRAINTS

- A. Pre-engineered kits of galvanized steel pipe straps with stainless steel band clamps and tee bolts, meeting requirements of the CISPI Installation Handbook.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install pipe and specialties in accordance with manufacturer's installation instructions.

3.02 PREPARATION FOUNDATION FOR UNDERGROUND BUILDING DRAINS

- A. Pipe Beds:
 - 1. PVC and ABS Pipe: Support pipe in trench with sand bags level and true to prevent sand, gravel or debris from interfering with the solvent cement process. After pressure testing is complete, gradually install bedding to maintain continuous pipe slope and prevent pipe deflection and then install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements and refer to ASTM D2321 "Underground Installation of Thermoplastic Pipe for Sewers and Gravity-flow Applications" for additional requirements.
 - 2. Cast Iron Soil Pipe: Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand bedding. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation and maintain continuous pipe slope. For piping with rock trench bottoms, provide sand pipe bed 6" underneath and around sides of pipe, including fittings. After pressure testing is complete, install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements.

3.03 PIPE APPLICATIONS - ABOVE GROUND, WITHIN BUILDING

- A. Install hubless, cast-iron soil pipe and fittings 15" and smaller for storm pipe.

3.04 PIPE APPLICATIONS - BELOW GROUND, WITHIN BUILDING

- A. Install hub-and-spigot, service weight, cast-iron, soil pipe and fittings with gasketed joints for 15 inch and smaller storm pipe.
- B. Install hubless, cast-iron soil pipe and fittings 15" and smaller for storm pipe.
- C. As a contractor's option with Owner approval, Install PVC Type DWV Plastic pipe and fittings for 24 inch and smaller storm pipe.

3.05 PIPE AND TUBE JOINT CONSTRUCTION

- A. Copper Tubing: Solder joints in accordance with the procedures specified in AWS "Soldering Manual."
- B. Cast-Iron Soil Pipe: Make hubless joints in accordance with the Cast-Iron Soil Pipe & Fittings Handbook, Chapter IV. Install Couplings as followings:
 - 1. Install heavy duty hubless couplings on storm drainage piping, including connections to roof drains.
 - 2. Install No-Hub fitting restraints on joints 5" and larger at:
 - a. Changes of direction from vertical to horizontal
 - b. 4" branch connections, including tees, wyes and wye combination fittings to storm drainage piping 5" and larger
 - c. Horizontal changes of direction 22-1/2 degrees and greater
- C. PVC DWV Pipe: Joining and installation of PVC drainage pipe and fittings shall conform to ASTM D2665.
- D. ABS to PVC Transition Joints: When joining ABS to PVC components (such as an ABS building drain to PVC sewer pipe) make joints using solvent cements conforming to ASTM D3138.
- E. Cast Iron to PVC Above Grade: Join cast iron to PVC with shielded transition couplings.
- F. Cast Iron to PVC Below Grade: Join cast iron to PVC with underground shielded adapter couplings.

3.06 INSTALLATION

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing, slope, expansion, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and all branch connections.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and sealer. Refer to Division 22 Section "Basic Piping Materials and Methods" for special sealers and materials.

- H. Underground Exterior Wall Penetrations: Seal pipe penetrations through underground exterior walls using sleeves and mechanical sleeve sealers. Refer to Division 22 Section "Basic Piping Material and Methods" for additional information.
- I. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings and floors, maintain the fire rated integrity. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.
- J. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.
- K. Foundation Penetrations: Where pipes pass through foundation walls above strip footings or under strip footings, protect pipes from building load with cast iron soil pipe sleeves two pipe sizes larger than the pipe. Sleeves installed under the strip footing shall be encased in concrete.
- L. Make changes in direction for drainage piping using appropriate 45 degree wyes, combination wye and eighth bend, or long sweep, quarter, sixth, eighth, or sixteenth bends. Sanitary tees or quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn pattern combination wye and eighth bends where two fixtures are installed back to back and have a common drain. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper sized standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.
- M. Install underground building drains to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.
- N. Install drainage piping pitched down at a minimum slope of 1/4 inch per foot (2 percent) for piping 3 inch and smaller, and 1/8 inch per foot (1 percent) for piping 4 inch and larger.
- O. Extend building drain to connect to service piping, of size and in location indicated for service entrance to building. Storm service piping is specified in a separate section of Division 2.
- P. Install 1 inch thick extruded polystyrene over underground building drain piping not under building. Width of insulation shall extend minimum of 12" beyond each side of pipe. Install directly over, and center on pipe center line.

3.07 HANGERS AND SUPPORTS

- A. General: Hanger, support, insulation protection shields, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
 - 2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.
- C. Install hangers at the following intervals and provide rods of diameter as listed below:

Nom. Pipe Size	Steel Pipe Max. Span	Copper Tube Max. Span.	Min. Rod Dia. - Inches Steel or Cast Iron	Min. Rod Dia. - Inches Copper or PVC
<u>In Inches</u>	<u>In Feet</u>	<u>In Feet</u>		
Up to 3/4	7	5	3/8	3/8
1	7	6	3/8	3/8

1-1/4	7	7	3/8	3/8
1-1/2	9	8	3/8	3/8
2	10	8	3/8	3/8
2-1/2	11	9	1/2	3/8
3	12	10	1/2	1/2
3-1/2	13	11	1/2	1/2
4	14	12	5/8	1/2
5	16	13	5/8	1/2
6	17	14	3/4	5/8
8	19	16	7/8	3/4
10	22	18	7/8	3/4
12	23	19	7/8	3/4

1. Support all sizes of hubless horizontal cast iron piping every five feet, except up to ten feet where ten foot sections are installed. Support all sizes of hubless horizontal cast iron piping every other joint, unless over four feet, then support each joint. Provide support adjacent to joint, not to exceed 18". Provide sway brace on horizontal piping at not more than 40' intervals to prevent horizontal movement. Provide support at each horizontal branch.
2. Support all sizes of vertical cast iron piping every ten feet.
3. Support all sizes of horizontal of PVC piping every four feet.
4. Support all sizes of vertical of PVC piping every floor, but not to exceed fifteen feet.
5. Support piping within 12" of each elbow or tee.

3.08 INSTALLATION OF PIPING SPECIALTIES

- A. Provide PVC DWV expansion joints every 30' on straight vertical PVC waste or sanitary stacks receiving hot water waste. Install expansion joint at middle travel for equal expansion and contraction travel. Provide riser clamps within 18" of each end of expansion joint. Install expansion joint per manufacturer's installation instructions.
- B. Install expansion joints on stacks or horizontal piping as indicated, and as required by the plumbing code.
- C. Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:
 1. as required by plumbing code;
 2. at each change in direction of piping greater than 45 degrees;
 3. at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping;
 4. at base of each vertical soil, waste, or storm water stack.
- D. Cleanout Covers: Install floor and wall cleanout covers for concealed piping, types as indicated.
- E. Floor Cleanouts: Install in below floor building drain piping at minimum intervals of 50' for piping 6" and smaller and 75' for larger piping.
 1. Install floor cleanouts in waterproof floors with waterproof membrane securely flashed with cleanout body flashing clamp so that no leakage occurs between cleanout body and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
- F. Exterior Cleanouts: Install exterior cleanouts embedded in a 18" x 18" x 8" block of concrete, flush with finished grade.

3.09 INSTALLATION OF AREA DRAINS

- A. Install area drains in locations indicated.
- B. Install area drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.
- C. Refer to architectural documents for floor slope requirements and set area drain elevation to match. Where architectural documents do not indicate the requirements, set the area drain

elevation depressed below the finished slab elevation as listed below to provide proper slope to drain:

<u>DEPRESSION IN INCHES</u>	<u>RADIUS OF AREA DRAINED - FEET</u>
1/2	5
3/4	10
1	15
1-1/4	20
1-1/2	25

- D. Provide P-traps for drains connected to combined sanitary and storm sewer.
- E. Install area drains in waterproof floors with waterproof membrane securely flashed with drain flashing clamp so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
- F. Position drains so that they are level, accessible and easy to maintain.

3.10 INSTALLATION OF ROOF DRAINS

- A. Install roof drains at low points of roof areas with the roof membrane securely flashed with drain flashing clamp so that no leakage occurs between drain and roof membrane.
- B. Install drain flashing collar or flange so that no leakage occurs between roof drain and adjoining roofing. Maintain integrity of waterproof membranes, where penetrated.
- C. Position roof drains so that they are accessible and easy to maintain.

3.11 FIELD QUALITY CONTROL

- A. Inspections
 - 1. Do not enclose, cover, or put into operation the storm drainage piping system until it has been inspected and approved by the authority having jurisdiction.
 - 2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
 - a. Rough-in Inspection: Arrange for inspection of the storm drainage piping system before concealed or closed-in after system is roughed-in.
 - b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.
 - c. Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspected by the plumbing official.
 - d. Reports: Prepare inspection reports, signed by the plumbing official.
- B. Piping System Test: Test storm drainage system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:
 - 1. Test for leaks and defects all new storm drainage piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
 - 2. Leave uncovered and unconcealed all new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.
 - 3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of storm drainage piping systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.

4. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
5. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.12 ADJUSTING AND CLEANING

- A. Clean interior of piping system. Remove dirt and debris as work progresses.
- B. Clean drain strainers and domes. Remove dirt and debris.

3.13 PROTECTION

- A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

END OF SECTION 22 14 00

SECTION 22 40 00 PLUMBING FIXTURES

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes plumbing fixtures and trim, fittings, and accessories, appliances, appurtenances, equipment, and supports associated with plumbing fixtures.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Joint Sealers," for materials and methods for sealing between plumbing fixtures and interior walls.
 - 2. Division 10 Section "Service Wall Systems" for wall modules with built-in plumbing fixtures.
 - 3. Division 22 Section "General Duty Valves for Plumbing Piping" for valves used as supply stops.

1.02 DEFINITIONS

- A. Accessible: Describes a plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped people.
Examples of accessory below are toilet seats, grab bars, and soap dishes.
- B. Accessory: Device that adds effectiveness, convenience, or improved appearance to a fixture but is not essential to its operation.
- C. Appliance: Device or machine designed and intended to perform a specific function.
- D. Appurtenance: Device or assembly designed to perform some useful function when attached to or used with a fixture.
- E. Equipment: Device used with plumbing fixtures or plumbing systems to perform a certain function for plumbing fixtures but that is not part of the fixture.
- F. Fitting: Fitting installed on or attached to a fixture to control the flow of water into or out of the fixture.
- G. Fixture: Installed receptor connected to the water distribution system, that receives and makes available potable water and discharges the used liquid or liquid-borne wastes directly or indirectly into the drainage system. The term "Fixture" means the actual receptor, except when used in a general application where terms "Fixture" and "Plumbing Fixture" include associated trim, fittings, accessories, appliances, appurtenances, support, and equipment.
- H. Roughing-In: Installation of piping and support for the fixture prior to the actual installation of the fixture.
- I. Support: Device normally concealed in building construction, for supporting and securing plumbing fixtures to walls and structural members. Supports for urinals, lavatories, and sinks are made in types suitable for fixture construction and the mounting required. Categories of supports are:
 - 1. Carrier: Floor-mounted support for wall-mounted water closet, and support fixed to wall construction for wall-hung fixture.
 - 2. Chair Carrier: Support for wall-hung fixture, having steel pipe uprights that transfer weight to the floor.
 - 3. Chair Carrier, Heavy Duty: Support for wall-hung fixture, having rectangular steel uprights that transfer weight to the floor.
 - 4. Reinforcement: Wood blocking or steel plate built into wall construction, for securing fixture to wall.
- J. Trim: Hardware and miscellaneous parts, specific to a fixture and normally supplied with it required to complete fixture assembly and installation.

- K. 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 Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
 - 1. Product data for each type of plumbing fixture specified, including fixture and trim, fittings, accessories, appliances, appurtenances, equipment, supports, construction details, dimensions of components, and finishes.
 - 2. Wiring diagrams for field-installed wiring of electrically operated units.
 - 3. Maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."
- B. Submit third party certification that faucets and trim for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372. The following faucets and trim need not comply:
 - 1. Electronic faucets
 - 2. Service sink faucets
 - 3. Flush valves
 - 4. Shower valves and heads

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with requirements of ANSI Standard A117.1, "Buildings and Facilities -- Providing Accessibility and Usability for Physically Handicapped People," Public Law 90-480, "Architectural Barriers Act, 1968," with respect to plumbing fixtures for the physically handicapped and "Americans with Disabilities Act Accessibility Guidelines for Buildings 1991" with respect to plumbing fixtures for the physically handicapped.
- B. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled.
 - 1. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- C. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of faucets and trim containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.
- D. Design Concept: The drawings indicate types of plumbing fixtures and are based on the specific descriptions, manufacturers, models, and numbers indicated. Plumbing fixtures having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions, operation, color or finish, or other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. Burden of proof for equality of plumbing fixtures is on the proposer.

1.05 SPARE PARTS

- A. Deliver spare parts to Owner. Furnish spare parts described below matching products installed, packaged with protective covering for storage, and identified with labels clearly describing contents.
- B. Faucet Washers and O-rings: Furnish quantity of identical units not less than 10 percent of amount of each installed.
- C. Faucet Cartridges and O-rings: Furnish quantity of identical units not less than 5 percent of amount of each installed.

- D. Flushometer Repair Kits: Furnish quantity of identical units not less than 10 percent of amount of each flushometer installed.
- E. Provide individual metal boxes or a hinged-top wood or metal box having separate compartments for each type and size of above extra materials.
- F. Toilet Seats: Furnish quantity of identical units not less than 5 percent of amount of each type toilet seat installed.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products in each category, by one of the following listed for that category:
 - 1. Water Closets:
 - a. American Standard, Inc.
 - b. Fiat Products.
 - c. Gerber Plumbing Fixture Corp.
 - d. Kohler Co.
 - e. PROFLO
 - f. Sloan Valve Co.
 - g. TOTO KIKI USA, Inc.
 - h. Zurn Plumbing Products Group
 - 2. Lavatories:
 - a. American Standard, Inc.
 - b. Fiat Products.
 - c. Gerber Plumbing Fixture Corp.
 - d. Kohler Co.
 - e. PROFLO
 - f. Sloan Valve Co.
 - g. TOTO KIKI USA, Inc.
 - h. Zurn Plumbing Products Group
 - 3. Sinks:
 - a. American Standard, Inc.
 - b. Elkay Manufacturing Co.
 - c. Just Manufacturing Co.
 - d. PROFLO
 - 4. Outlet Boxes:
 - a. Guy Gray Manufacturing Co., Inc.
 - b. Symmons Industries, Inc.
 - c. Oatey Co.
 - 5. Emergency Equipment:
 - a. Bradley Corp.
 - b. Chicago Faucet Co.
 - c. ENCON Safety Products
 - d. Guardian Equipment.
 - e. Haws Drinking Faucet Co.

- f. Speakman Co.
 - g. Stingray Systems
 - h. Water Saver Faucet Co.
- 6. Toilet Seats:
 - a. Bemis Mfg. Co.
 - b. Beneke Div.; Sanderson Plumbing Products, Inc.
 - c. Church Seat Co.
 - d. Kohler Co.
 - e. Olsonite Corp.
 - f. Sperzel Industries, Inc.
- 7. Flushometers – Piston Type:
 - a. American Standard, Inc
 - b. Kohler Co.
 - c. Sloan Valve Co.
 - d. Zurn Industries, Inc.; Flush Valve Operations.
- 8. Commercial/Industrial Cast-Brass Faucets:
 - a. American Standard, Inc.
 - b. Chicago Faucet Co.
 - c. Delta-Commercial
 - d. Speakman Co.
 - e. T & S Brass and Bronze Works, Inc.
 - f. Zurn Industries, LTD. "Aqua Spec"
- 9. Stop Valves & Supplies:
 - a. Brass Craft Subsidiary; Masco Co.
 - b. Chicago Faucet Co.
 - c. Engineered Brass Company
 - d. Kohler Co.
 - e. McGuire Manufacturing Co., Inc.
 - f. PROFLO
 - g. T & S Brass and Bronze Works, Inc.
 - h. Watts Brass and Tubular
 - i. Zurn Industries
- 10. P-traps, Drains & Miscellaneous Fittings:
 - a. Brass Craft Subsidiary; Masco Co.
 - b. Dearborn Brass
 - c. Engineered Brass Company
 - d. McGuire Manufacturing Co., Inc.
 - e. PROFLO
 - f. Watts Brass and Tubular
 - g. Zurn Industries
- 11. Supports:
 - a. Josam Co.
 - b. Smith (Jay R.) Mfg. Co.
 - c. Wade Div.; Tyler Pipe.

- d. Watts Drainage Products
 - e. Zurn Industries, Inc.; Hydromechanics Div.
12. Disposers:
- a. General Electric Co.
 - b. Hotpoint; General Electric Co.
 - c. In-Sink-Erator Div.; Emerson Electric Co.
 - d. KitchenAid, Inc.
 - e. Thermador/Waste King; A Masco Co.

2.02 PLUMBING FIXTURES, GENERAL

- A. Provide plumbing fixtures and trim, fittings, other components, and supports as specified on the drawings and below:

2.03 FAUCETS

- A. Faucets General: As described on the drawings.
- 1. Electronic faucets shall be of the same manufacturer as the water closet and urinal flush valves.

2.04 STOP VALVES & SUPPLIES

- A. Supplies General: As described on the drawings.
- 1. Exposed piping and parts shall be polished chrome plated.

2.05 P-TRAPS, DRAINS AND MISCELLANEOUS FITTINGS:

- A. Fittings General: As described on the drawings, except as listed below.
- 1. Exposed piping and fittings shall be polished chrome plated.
 - 2. Fittings installed concealed inside a plumbing fixture or within wall construction may be without chrome plate finish.
 - 3. Fitting and faucet bodies for domestic water distribution shall be of lead free brass or lead free cast bronze.
- B. Escutcheons: Wall flange with set screw.
- C. Escutcheons: Polished chrome-plated, sheet steel wall flange with friction clips.
- D. Deep Pattern Escutcheons: Wall flange with set screw or sheet steel wall flange with friction clips, of depth adequate to conceal protruding roughing-in fittings.

2.06 FLUSHOMETERS

- A. Provide flushometers compatible with fixtures, with features and of consumption indicated As described on the drawings.
- 1. Exposed metal parts shall be polished chrome plated.
 - 2. Flush valves installed within wall construction may be without chrome plate finish.

2.07 TOILET SEATS

- A. General: As described on the drawings.

2.08 DISPOSERS

- A. Disposers: As specified on the drawings.

2.09 PLUMBING FIXTURE SUPPORTS

- A. Supports: ASME A112.6.1M, categories and types as required for wall-hanging fixtures specified, and wall reinforcement.
- B. Support categories are:
- 1. Carriers: Supports for wall-hanging water closets and fixtures supported from wall construction. Water closet carriers shall have an additional faceplate and coupling when used for wide pipe spaces. Provide tiling frame or setting gauge with carriers for wall-hanging water closets.

2. Chair Carriers: Supports with steel pipe uprights for wall-hanging fixtures. Urinal chair carriers shall have bearing plates.
 3. Chair Carriers, Heavy Duty: Supports with rectangular steel uprights for wall-hanging fixtures.
 4. Reinforcement: 2-inch by 4-inch wood blocking between studs or 1/4-inch by 6-inch steel plates attached to studs, in wall construction, to secure floor-mounted and special fixtures to wall.
- C. Support Types: Provide support of category specified, of type having features required to match fixture.
- D. Provide supports specified as part of fixture description, in lieu of category and type requirements above.

2.10 INSULATION KITS

- A. Insulation kits for lavatory and sink waste and supplies of vinyl plastic with reusable fasteners and openings for access to supply stop handles.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install fixtures, trim and supports in accordance with manufacturer's installation instructions.

3.02 APPLICATION

- A. Install plumbing fixtures and specified components, in accordance with designations and locations indicated on Drawings.
- B. Install supports for plumbing fixtures in accordance with categories indicated, and of type required:
1. Carriers for following fixtures:
 - a. Wall-hanging water closets.
 - b. Wall hanging lavatories
 - c. Wall hanging electric water coolers and drinking fountains.
 - d. Wall-hanging fixtures supported from wall construction.
 2. Chair carriers for the following fixtures:
 - a. Wall-hanging urinals.
 - b. Wall-hanging lavatories and sinks.
 - c. Wall-hanging drinking fountains and electric water coolers.
 3. Heavy-duty chair carriers for the following fixtures:
 - a. Accessible lavatories.
 - b. Fixtures where specified.
 4. Reinforcement for the following fixtures:
 - a. Floor-mounted lavatories required to be secured to wall.
 - b. Floor-mounted sinks required to be secured to wall.
 - c. Recessed, box-mounted electric water coolers.
 - d. Wall mounted and mop sink faucets.

3.03 INSTALLATION OF PLUMBING FIXTURES

- A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturers' written installation instructions, roughing-in drawings, and referenced standards.
- B. Install floor-mounted, floor-outlet water closets with closet flanges and gasket seals.
- C. Install floor-mounted, back-outlet water closets with fittings and gasket seals.

- D. Install wall-hanging, back-outlet water closets with support manufacturer's tiling frame or setting gauge.
- E. Install wall-hanging, back-outlet urinals with gasket seals.
- F. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.
- G. Fasten floor-mounted fixtures and special fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.
- H. Fasten wall-mounted fittings to reinforcement built into walls.
- I. Fasten counter-mounting-type plumbing fixtures to casework.
- J. Secure supplies behind wall or within wall pipe space, providing rigid installation.
- K. Set shower floors in leveling bed of cement grout.
- L. Install stop valve in an accessible location in each water supply to each fixture.
- M. Install trap on fixture outlet except for fixtures having integral trap.
- N. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork. Use deep pattern escutcheons where required to conceal protruding pipe fittings.
- O. Seal fixtures to walls, floors, and counters using a sanitary-type, one-part, mildew-resistant, silicone sealant in accordance with sealing requirements specified in Division 7 Section "Joint Sealers." Match sealant color to fixture color.
- P. Install insulation kits on ADA compliant sink and lavatory waste, continuous wastes, hot and cold water supplies where indicated on the drawings and as required by the ADA.

3.04 CONNECTIONS

- A. Piping installation requirements are specified in other sections of Division 22. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 - 1. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other sections of Division 22.
 - 2. Install piping connections indicated between appliances and equipment specified in other sections, direct connected to plumbing piping systems.

3.05 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.

3.06 ADJUSTING AND CLEANING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust disposers, hot water dispensers, and controls. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at drinking fountains, electric water coolers, and faucets, shower valves, and flushometers having controls, to provide proper flow and stream.
- D. Replace washers of leaking and dripping faucets and stops.
- E. Clean fixtures, fittings, and spout and drain strainers with manufacturers' recommended cleaning methods and materials.
- F. Adjust faucet wrist blade handles perpendicular to the spout while in the closed position.
- G. Review the data in Operating and Maintenance Manuals. Refer to Division 1 Section "Project Closeout."

3.07 FIXTURE SCHEDULE

- A. Provide plumbing fixtures as specified on the drawings.
- B. Install rough-in for plumbing fixtures as scheduled on the drawings.

3.08 MOUNTING HEIGHTS SCHEDULE:

- A. Refer to the architectural drawings for plumbing fixture mounting heights. Unless indicated otherwise, install plumbing fixtures with the mounting heights as listed below with final approval by the Architect:

FIXTURE	MOUNTING HEIGHT
Lavatory or Sink	
Standard Height	31" floor to rim
ADA Accessible	34" floor to rim
Water Closet	
Standard	15" floor to rim
ADA Accessible	17" to 19" floor to top of seat
Water Cooler or Drinking Fountain	
Standard Height	41" floor to spout
ADA Accessible	36" floor to spout
Clinic Service Sinks	30" floor to rim
Surgeon's Scrub-up Sinks	35" floor to front rim
Ice Maker Outlet Boxes	24" floor to center of box
Washing Machine Outlet Boxes	42" floor to rim
Janitor's Sink Faucet Fittings	42" floor to centerline

END OF SECTION 22 40 00

SECTION 22 61 00

GAS AND VACUUM SYSTEMS FOR HEALTH CARE FACILITIES

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes oxygen, medical air, medical vacuum, nitrous oxide, nitrogen, carbon dioxide, and waste anesthetic gas disposal (WAGD) systems, including tubing, piping, fittings, equipment, and related accessories. Note that waste anesthetic gas disposal system (WAGD) is indicated as evacuation (EV) on the drawings.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "General Plumbing Requirements" for trenching and backfilling materials and methods for underground piping installations.
 - 2. Division 7 Section "Joint Sealers" for materials and methods for sealing pipe penetrations through basement and foundation walls and fire and smoke barriers.
 - 3. Division 11 Section "Equipment" for ceiling-mounted service columns, headwall units, and modular patient services units with medical gas outlets.
 - 4. Division 22 Section "Coordination" for basic requirements for electrical components that are an integral part of packaged system components.
 - 5. Division 22 Section "Identification, for Plumbing Piping and Equipment" for labeling and identification of gas and vacuum piping.
 - 6. Division 22 Section "Common Work Results for Plumbing" for materials and methods for fire barrier penetrations, wall and floor penetrations and equipment pads.
 - 7. Division 22 Section "Basic Piping Material and Methods" for materials and methods for strainers, flexible connectors, unions, flanges and flange kits, and mechanical sleeve seals.
 - 8. Division 22 Section "Hangers and Supports for Plumbing Piping" for materials and methods for hanging and supporting gas and vacuum piping.

1.02 DEFINITIONS

- A. Medical Gas System: The complete system to convey medical gases for direct patient application from central supply systems, including bulk tanks, manifolds, and medical air compressors, with pressure and operating controls, alarm warning systems, related components, and piping networks extending to station outlets at patient use points.
- B. Medical Vacuum System: The complete system of central-vacuum-producing equipment with pressure and operating controls, shut-off valves, alarm-warning systems, gauges, and a network of piping extending to and terminating with suitable station inlets at locations where patient suction may be required.
- C. Unless otherwise indicated herein, for the purposes of this Section, the term "medical gas system" shall include "medical vacuum system" also.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.
 - 1. Product data for the following products:
 - a. Valves
 - b. Medical gas system accessories
 - c. Medical gas alarm system
 - 2. Wiring diagrams for medical gas alarm systems, including ladder-type diagrams for interlock and control wiring required for final installation. Differentiate between portions of wiring that are factory installed and portions that are field installed.

3. Inspection and test reports specified in "Field Quality Control" in this Section.
4. Certificates of inspections and tests from independent testing agency specified in "Field Quality Control" and "Project Closeout Documents" in this Section.
5. Certificates indicating that medical gas tubing, fittings, valves, and other pipeline components are cleaned for oxygen service and are marked and sealed per NFPA 99.
6. Maintenance data for inclusion in Operating and Maintenance Manuals.
7. Brazers' qualification certificates, certifying that brazers meet the quality requirements specified under "Medical Gas and Vacuum System Brazers" and "Medical Gas and Vacuum System Installers" below.
8. Brazer brazing specifications indicating the proper procedure for the individual brazers to follow.
9. Verifier and Certifier certificates, certifying that verifiers and certifiers meet the quality requirements as specified under "Medical Gas System Inspector/Verifier" below.

1.04 QUALITY ASSURANCE

- A. Installation of the medical gas systems shall comply with the following:
 1. 2018 edition of NFPA 99 "Health Care Facilities Code"
 2. 2018 Uniform Plumbing Code
 3. American Society of Sanitary Engineering (ASSE) Series 6000
 4. The Missouri (State) Department of Health
 5. City of Lee's Summit
 6. Owner's Insurance Underwriter
 7. Authority Having Jurisdiction (AHJ)
 8. Applicable editions of Compressed Gas Association (CGA) standards:
 - a. G-4.1 "Cleaning Equipment for Oxygen Service"
 - b. G-4.3 "Commodity Specification for Oxygen"
 - c. RC-7 "Compressed Air for Human Respiration"
 - d. C-7.1 "American National Standard Commodity Specification for Air"
- B. Electrical wiring of equipment and alarm systems shall comply with the 2017 edition of NFPA 70 "National Electrical Code."
- C. Equipment shall comply with UL 544 "Standard for Medical and Dental Equipment" and installation shall comply with local, state, and federal codes.
- D. Equipment shall be listed and labeled by the Nationally Recognized Testing Laboratory. The terms "Listed" and "Labeled" shall be as defined in the "National Electrical Code," Article 100.
- E. Pipe joint make-up shall comply with ANSI/AWS A5.8, "Specifications for Brazing Filler Metal."
- F. Provide compatible accessories, tube, fittings, and valves for each system.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store large medical gas accessories on factory-installed shipping skids, tubing with sealing plugs in ends or with end protection, and small accessories in factory-fabricated fiberboard containers.
 1. Store precleaned and sealed medical gas tube, fittings, valves, and accessories with sealing plugs and sealing packaging intact.
 2. Label medical gas tube, fittings, valves, and accessories that have not been precleaned, and that have been precleaned but have seal or packaging that is not intact, with temporary labels indicating that cleaning is required before installation.
 3. Material that has become contaminated and is no longer suitable for oxygen service shall not be installed.

4. Provide a separate designated storage area for all medical gas equipment, piping, outlets, etc. The designated storage area shall be protected, dry, have no construction debris or traffic, and shall be utilized only for the storage of medical clean piping and equipment; shall not be utilized to store any non-medical gas and vacuum piping or equipment. The designated separate storage area shall be labeled as such to prevent non-medical gas and vacuum piping and equipment from being accidentally stored there and potentially being mistaken for medical gas piping and equipment.

1.06 PRE-CONSTRUCTION COORDINATION MEETING

- A. Before medical gas piping and equipment installations begin, the General Contractor shall organize a Pre-Construction Meeting for the purposes of reviewing stockpiled medical gas piping and equipment, storage locations, installer and brazer certifications, certifications of verifiers and inspectors, and to review the verification and inspection procedures required for the project.
- B. The pre-construction meeting shall be held at the project site, at a date and time convenient to the Owner. The meeting invitation shall include at a minimum the Owner (or his/her representative), the General Contractor, installing medical gas contractor, architect, engineer, verifier, inspector, and local authority having jurisdiction. All invitees shall be given minimum 48-hour notice of meeting time and date. If invitees can not physically be on site to attend the meeting a conference call number shall be set up to allow for virtual participation.

1.07 PRE-CONSTRUCTION VERIFIER STANDING PRESSURE AND PARTICULATE TEST FOR EXISTING FACILITY

- A. Before medical gas piping and equipment installations begin, the medical gas verifier shall perform a standing pressure and vacuum test to document the performance of the existing medical gas system. These results shall be utilized as a baseline when the final standing pressure and vacuum tests occur.
- B. Before medical gas piping and equipment installations begin, the medical gas verifier shall perform a particulate and purity test to document the performance of the existing medical gas system. These results shall be utilized as a baseline when the final particulate and purity tests occur.

1.08 PRE-CONSTRUCTION CONNECTION TEST FOR EXISTING FACILITY

- A. Before medical gas piping and equipment installations begin, the medical gas installer shall perform shut-off of the affected area valve, wait a minimum of 15 minutes, and the facility management shall check what alarms are activated by this action before cutting into any pipe. Take all steps necessary to make sure that the renovated piping on the plans matches field conditions.

1.09 PROPER ABANDONEMENT

- A. Do not abandon any medical gas piping/equipment in place.

1.10 MEDICAL GAS SYSTEMS INSPECTOR/VERIFIER

- A. The Medical Gas Systems Inspector/Verifier shall be contracted through the Construction Manager or Owner. The inspector/verifier shall not be hired or contracted by the medical gas installer.
- B. Verification is required when a medical gas system is breached, pipeline intrusion, or component replacement.
- C. The renovated portion of the system shall meet all the requirements of the adopted NFPA 99 version listed above.
- D. The Medical Gas Systems Inspector/Verifier shall be trained and certified in accordance with ASSE Standard 6020, "Professional Qualifications Standard for Medical Gas Systems Inspectors" and ASSE Standard 6030, "Professional Qualifications Standard for Medical Gas Systems Verifiers." Inspector/Verifiers shall have a minimum of two (2) years of documented practical experience in the inspection/verification of medical gas pipe line systems.

- E. Medical Vacuum System Inspector/Verifier Certification to Standard 6020 and 6030 shall be through a recognized third party certification agency. Certification shall include the successful completion of a minimum 32-hour training course including a written and a practical examination covering all facets of ASSE Standard 6030, 6020, NFPA 99, and NFPA 55.
- F. The Inspector/Verifier shall possess a current certificate of insurance, in the name of the individual or employing verification company, for general liability, completed operations, and as applicable, products liability insurance. The Inspector/Verifier shall provide the Owner and Engineer with a copy of insurance certificate.
- G. Inspector/Verifiers shall complete report forms that include at a minimum the following items: date of test, medical gas verifier/installer identification, repairs and service performed, equipment warning systems, master, area and local alarm systems, other items as required by AHJ, pressure regulating valves, pressure relief valves, retest information, shut-off valves (source, main, riser, zone, service, etc.), source equipment, station outlets and inlets, and visual observation of physical conditions. Refer to ASSE Series 6000 Appendices B, C, and D for required checklist information.
- H. Testing shall be conducted and test reports shall be submitted to the Engineer and Owner for approval.

MEDICAL GAS SYSTEM INSTALLERS

- A. All medical gas system installers shall be trained and certified in accordance with ASSE Standard 6010, "Professional Qualifications Standard for Medical Gas Systems Installers." Installers shall have a minimum of four (4) years of documented practical experience in the installation of piping systems.
- B. The medical gas systems installers shall be trained and certified to Standard 6010 through a recognized third party certification agency. Certification shall include the successful completion of a minimum 32-hour training course including a written and a practical examination covering all facets of ASSE Standard 6010, NFPA 99, and NFPA 55.
- C. Furnish to the Engineer and Owner photocopies of third party ASSE Standard 6010 certification for each and every installer. Certifications shall include installers name, expiration date, certification number, and name of certifying agency. These certifications must be provided before beginning work. A simple list of installers' names shall not be considered acceptable.
- D. Installers shall notify an inspector certified in accordance with ASSE Standard 6020 before any and all tests are performed so the results may be witnessed and recorded.
- E. Installers shall record performance test results on a form similar to ASSE Series 6000 Appendix I, "Medical Gas System Installer Performance Testing Record". Provide Engineer and Owner with copies of all test reports.
- F. All supervisors, crew chiefs, etc. engaged in overseeing and/or directing medical gas systems installation or modification shall also be required to meet these standards.

1.12 MEDICAL GAS SYSTEM BRAZERS

- A. The installation of medical gas systems shall be made by qualified, competent brazers who are experienced in making such installations. Brazing shall be performed only by brazers qualified under NFPA 99.
- B. Prior to any installation work, furnish to the Engineer and Owner photocopies of the qualification of individual brazers that is required under NFPA 99..
- C. Prior to any installation work, furnish to the Engineer and Owner photocopies of the Record of Continuity of Brazer Qualifications for each brazer.
- D. Brazing procedures and brazer performance for the installation of medical gas piping shall be qualified in accordance with either Section IX, "Welding and Brazing Qualifications," of the ASME Boiler and Pressure Vessel Code or AWS B2.2, Standard for Brazing Procedure and Performance Qualifications, both as modified by NFPA 99.

1.13 PROJECT SCHEDULING

- A. Any construction work which will require the facility's medical gas systems to be shut down shall require a minimum of 7 day advance notification to the Owner. All shutdown procedures shall comply with ASSE Series 6000 and facility requirements.
- B. Schedule work to ensure all medical gas piping, equipment, outlets, etc. are installed, and that all medical gas systems are tested and certified prior to substantial completion.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. The manufacturer's products listed herein and provided shall be compatible with the facility's existing medical gas equipment, components, and devices, where applicable, and shall be approved by the Owner.
- B. One manufacturer, unless otherwise specified herein or on the Drawings, shall supply the medical gas equipment, components, and devices as listed below. Refer to the Drawings for model numbers.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Systems Accessories:
 - a. Allied Healthcare Products, Chemetron Div.
 - b. Amico Corp.
 - c. Beacon Medaes
 - d. Ohio Medical Corp., Squire-Cogswell Div.
 - e. Patton's Medical
 - 2. Zone Valve Boxes:
 - a. Allied Healthcare Products, Chemetron Div.
 - b. Amico Corp.
 - c. Beacon Medaes
 - d. Ohio Medical Corp., Squire-Cogswell Div.
 - e. Patton's Medical
 - 3. Alarm Systems:
 - a. Amico Corp.
 - b. Beacon Medaes
 - c. Ohio Medical Corp., Squire-Cogswell Div.
 - d. Patton's Medical
 - 4. Wall/Ceiling Outlets:
 - a. Allied Healthcare Products, Chemetron Div.
 - b. Amico Corp.
 - c. Beacon Medaes
 - d. Ohio Medical Corp., Squire-Cogswell Div.
 - 5. Medical Gas Flowmeters
 - a. Beacon Medaes

2.02 COMPONENTS, GENERAL

- A. Copper tube, fittings, valves, and other piping components shall be precleaned for oxygen service by the manufacturer in accordance with CGA Pamphlet G-4.1 prior to installation and

shall be delivered plugged, capped, or sealed and permanently labeled or marked per NFPA 99.

- B. On-site cleaning of the interior surfaces of tubes, valves, fittings, and other piping components prior to brazing shall be limited. Refer to Part 3, Article "Preparation."
- C. Copper tube and fitting sizes are nominal inside diameter.

2.03 TUBE MATERIALS

- A. Refer to Part 3, Article "Tube Applications", for identification of systems where the materials listed below are used.
- B. Precleaned and Sealed Copper Tube: ASTM B819, Type K or L, hard drawn temper, seamless medical gas tubing marked "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED."

2.04 TUBE FITTINGS

- A. Wrought Copper Solder-Joint Fittings: ANSI B16.22, solder-joint, pressure type designed for brazed joints.
- B. Bronze Tube Flanges: ANSI B16.24, Class 300, designed for brazed tubing connection.
- C. Flexible Connectors shall be provided with medical air compressor and medical vacuum pump as a component of the packaged units.
- D. Threaded joints and connections shall be permissible where indicated in NFPA 99.

2.05 TUBE AND FITTING JOINING MATERIALS

- A. Screwed Joint Pipe Tape: Polytetrafluoroethylene (PTFE) plastic.
- B. Gasket Material: ANSI B16.21, nonmetallic, flat, asbestos-free, and suitable for oxygen use.
- C. Brazing Filler Metals: ANSI/AWS A5.8, BAg-5, with a cadmium content of zero, with approved flux suitable for oxygen service.
- D. Brazing Filler Metals: ANSI/AWS A5.8, BCuP-5, with a minimum silver content of 15%. Flux is prohibited.

2.06 VALVES

- A. Shut-off Valves 4 Inches and Smaller: Bronze-body, three-piece, full-size port, bolted-ball type, with chrome-plated brass ball, with Teflon (TFE) seats, buna or Teflon stem seals, blow-out proof stem, Type K copper tube extensions suitable for brazing and with protective end covers, quarter-turn operation between open and closed positions, designed for working pressures up to 600 psi or vacuum service up to 29 inch Hg, and factory-cleaned for oxygen service. Valves shall be of the locking type where indicated on the Drawings.
- B. Check Valves 3 Inches and Smaller: Bronze-body, straight-through pattern, spring-loaded plunger, designed for working pressures up to 400 psi, and factory-cleaned for oxygen service.
- C. Safety Valves: Bronze-body with settings to match system requirements and factory-cleaned for oxygen service.
 - 1. Pressure Relief Valves: Bronze construction and designed for oxygen service.
 - 2. Vacuum Relief Valves: Equipment manufacturer's option.
- D. Automatic Drain Valves: Corrosion-resistant metal body and internal parts, 200 psig minimum rated working pressure, and capable of automatic discharge of collected condensate.

2.07 ZONE VALVE BOXES

- A. General: Valve rough-in box shall be constructed of minimum 18-gauge steel or extruded aluminum for recessed mounting, with holes for medical gas tubing and anchors. Provide for single or multiple valve installation and in sizes as indicated on the Drawings to permit manual operation of valves.
- B. Shut-off Valve(s): Same as described in Part 2, Article "Valves" and shall be provided with color-coded medical gas identification labels and pressure gauge ports in the extension downstream of the valve (upstream for vacuum). The valve body and pipe stubs shall be chrome-plated to beyond the valve rough-in box.

- C. Interior Finish: Factory-applied white enamel.
- D. Finishing Window Frame: Anodized extruded aluminum sections with mitered welded corners and provided with clear or tinted transparent removable plastic window with pull ring to remove in an emergency and factory or field-installed labeling (including space for rooms served) in accordance with NFPA 99. The window shall be labeled "Caution: Medical Gas Control Valve – Close Only in Emergency."
- E. Pressure/Vacuum Gauge(s): Factory-installed with 2 inch dial in accordance with ASME B40.1, Grade B. Gauge range shall be such that the normal operating pressure is within the middle third of the total range.

2.08 ALARM SYSTEMS

- A. General: Medical gas alarm systems shall consist of compatible alarm panels, remote sensing devices, and other related components where indicated and as required by NFPA 99. Power and control wiring are specified in Division 26.
- B. Electrical Components: Designed for continuous service and to operate on power supplied from 120V power source to alarm panels and have connections for 24V or 12V a.c. low-voltage wiring to remote sensing devices. Provide step-down transformers where required.
- C. Actuating Devices: Pressure and vacuum switches or pressure transducer sensors, mounted locally or remotely as indicated on the Drawings, shall provide for continuous line monitoring with electrical connections for each medical gas alarm system. Switches shall be housed in a NEMA 4 watertight enclosure and shall be factory-cleaned for oxygen service.
 - 1. High-low pressure switches for oxygen, medical air, nitrous oxide, and carbon dioxide systems: Up to 80 psig operating range.
 - 2. Low vacuum switches for medical vacuum and WAGD systems: Up to 30 inch Hg. Range.
 - 3. Gauges: Provide main line gauges in medical gas/vacuum piping mains adjacent to main line pressure/vacuum switches.
- D. Alarm Panels: Recessed, closed-circuit, self-monitoring type with LED digital readouts, solid state with plug-in circuit boards, and factory-wired with audible and color-coded visible signals to indicate functions as specified herein and required by NFPA 99. Panels shall be properly labeled to indicate rooms or areas served by each medical gas. Provide alarm panels with interface capabilities to automated building management system where indicated.
- E. Enclosures: Constructed of minimum 18-gauge steel or aluminum with mounting brackets and knockouts for electrical tubing connections.
- F. Area Alarm Panels: Provide area alarm panels with 1/4" Type K copper monitoring extensions for local sensors or dry contacts for remote sensors where indicated. Area alarm panels shall alarm when any of the following conditions occur:
 - 1. Oxygen: Local line pressure drops to 40 psig and below or rises to 60 psig and above.
 - 2. Medical Air: Local line pressure drops to 40 psig and below or rises to 60 psig and above.
 - 3. Medical Vacuum: Local line vacuum drops to 12 inches Hg. and below.

2.09 MEDICAL GAS SYSTEM ACCESSORIES

- A. General: Provide the following medical gas system accessories by the same manufacturer.
- B. Quick-Connect Recessed Wall Outlets: Include brass valve and body block with seals in roughing-in and finishing assemblies, color coded front plate, one piece chrome fascia plate with medical gas identification, 1/4-inch inside diameter Type K copper tube brazed to valve, and pressure outlets equipped with a primary and secondary check valve to prevent gas flow when the primary valve is removed. Outlet bodies shall be indexed to prevent interchange between services, constructed to permit one-handed connection and removal of equipment with positive locking ring which retains equipment stem in valve during use. Outlets shall be of modular design and include a gas specific mounting plate to permit ganging of multiple outlets.
- C. DISS (Diameter Index Safety System) Type Recessed Ceiling Outlets: Include brass valve and body block with seals in roughing-in and finishing assemblies, color coded front plate, one piece

chrome fascia plate with medical gas identification, 1/4-inch inside diameter Type K copper tube brazed to valve, and pressure outlets equipped with a primary and secondary check valve to prevent gas flow when the primary valve is removed. Outlet bodies shall be indexed to prevent interchange between services. Outlets shall be of modular design and include a gas specific mounting plate to permit ganging of multiple outlets. Outlets shall be provided with hose assemblies with 60" long, FDA approved medical grade thermoplastic conductive reinforced rubber hose with color-coding complying with CGA C-9 standard, DISS female inlets and quick-connect outlets, and hose retractor with stainless steel housing and 48" heavy duty cable mounted to outlet cover plate.

- D. Vacuum Bottle Slide Brackets: Bottle slide and mounting assembly matching pattern of vacuum outlet. Provide 1 slide bracket for each wall-mounted vacuum inlet, except where no slide bracket requirement is indicated.
- E. Power and Medical Gas Columns: Provided under another division of work. Make final medical gas piping connections to columns above ceiling, unless otherwise indicated.

2.10 MEDICAL GAS FLOWMETERS

- A. Flowmeter operated by thermal conductivity to meter direct mass flow. Includes temperature and pressure compensation, precise measurement with standard turndown of 100 to 1 and maximum resolution of 1000 to 1. No moving parts.
- B. Stainless flow condition tube for laminar flow. Enclosed in rugged cast aluminum housing suitable for indoor or outdoor applications.
- C. Display is high contrast OLED with photocell activated screen saver to extend display life. Displays provided include:
 - 1. Flow rate in CFM
 - 2. Bar graph indicator
 - 3. Total flow
 - 4. Temperature
 - 5. Calibration mW
- D. Flowmeter and flow conditioning tubes are cleaned and bagged for oxygen service. Flowmeter shall comply with NFPA 99 2018.

PART 3 - EXECUTION

1.

3.02 PREPARATION

- A. On-site cleaning of the interior surfaces of tubes, valves, fittings, and other piping components shall be limited to recleaning surfaces in the immediate vicinity of the joints that have become contaminated prior to brazing.
- B. When precleaned medical gas piping components must be recleaned due to contamination, perform the following procedures:
 - 1. Clean interior surfaces at the joints of piping components free of oil, grease, and other readily oxidizable materials as required for oxygen service.
 - 2. Wash surfaces of components at the joints in a clean, hot water/alkaline solution of sodium carbonate or trisodium phosphate in proportion of one pound of chemical to three gallons of potable water.
 - a. Thoroughly scrub to ensure complete cleaning.
 - b. Rinse with clean, hot potable water after washing to remove cleaning solution.

3.03 TUBE APPLICATIONS

- A. Install Type L, hard drawn copper tube with wrought copper fittings and brazed joints for sizes 1/2 inch and larger, above ground, within building.

- B. Connections to pressure gauges and alarm switches and monitoring line runouts to area alarm panels shall be 1/4 inch in size, unless indicated otherwise, of same material as main and branch tubing.

3.04 PIPING INSTALLATION, GENERAL

- A. Install eccentric reducers where pipe is reduced in size in the direction of flow, with bottoms of both pipes and reducer flush.
- B. Install horizontal piping as high as possible. Install vertical piping tight to columns or walls. Allow sufficient space above removable ceiling panels to allow for panel removal.
- C. Install piping specialties in accordance with Division 22 Section "Basic Piping Materials and Methods."
- D. Install thermometers and pressure gauges where indicated on the drawings. Pressure gauge and thermometers are specified in Division 22 Section "Meters and Gauges for Plumbing Piping."
- E. Piping exposed to physical damage shall be adequately protected.
- F. All piping shall be pitched so as to drain to accessible locations. All branch takeoffs or runouts shall be taken off above the centerline of the main or branch pipe and rise vertically or at an angle of not less than 45 degrees from the vertical.
- G. Fire Barrier Penetrations: Where pipes pass through fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.
- H. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.
- I. Joints at Valve Assemblies: Provide bronze unions downstream of shutoff valves at valve assemblies. Unions are not required at flanged connections. Unions are specified in Division 22 section "Basic Piping Materials and Methods".

3.05 TUBING JOINT CONSTRUCTION

- A. Particular care shall be exercised in the storage and handling of tube and fittings which shall be capped or plugged to prevent contamination before final assembly. Tools used in cutting or reaming shall be kept free from oil or grease. Contaminated material that is no longer suitable for oxygen service shall not be installed, but shall be replaced with new.
- B. Bends: Changes in direction requiring turns or offsets shall be made by brazed wrought copper fittings.
- C. Unions shall not be permitted in the medical gas piping distribution system.
- D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe tape, suitable for the service for which the pipe is intended, on the male threads at each joint. Tighten joint to leave not more than 3 threads exposed. Leave first thread clean if possible.
- E. Openings in the piping system shall be kept capped or plugged during and after installation to prevent loss of purge gas while brazing and to prevent debris or other contaminants from entering the system.
- F. Brazing For Copper Tube and Fittings:
 - 1. Braze joints in accordance with NFPA 99 with BCuP-5 brazing filler metal.
 - 2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making brazed joints. Wipe tube and fittings clean. Prevent the entry of matter into the tube. If matter enters the tube, replace the tube or clean the tube in the field per NFPA 99. Use of flux is prohibited.

3. Continuously purge each with oil-free dry nitrogen during brazing procedures to prevent oxidation and scale formation on the inside surface of the copper tube and joints. The nitrogen flow shall be maintained until the joint is cool to the touch.
 4. Clean the outside of the tube and fittings after assembly with hot water.
- G. Brazing For Dissimilar Metals:
1. Braze joints in accordance with NFPA 99 with BAg-5 brazing filler metal and approved flux suitable for oxygen service.
 2. Thoroughly clean pipe and tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making brazed joints. Wipe tube and fittings clean. Prevent the entry of matter into the tube. If matter enters the tube, replace the tube or clean the tube in the field per NFPA 99.
 3. Continuously purge each with oil-free dry nitrogen during brazing procedures to prevent oxidation and scale formation on the inside surface of the copper tube and joints. The nitrogen flow shall be maintained until the joint is cool to the touch.
 4. Clean the outside of the tube and fittings after assembly with hot water.

3.06 INSTALLATION OF VALVES

- A. Valve Applications:
1. Provide ball valves specified herein for shutoff duties at the medical gas source, main line, base-of-risers, and where indicated on the Drawings.
 2. Provide check valves specified herein at cylinder manifold and bulk tank systems in the primary supply main, upstream of the point of intersection with the secondary or reserve supply main as required by NFPA 99, at emergency oxygen inlet, and where indicated on the Drawings.
 3. Provide a pressure relief valve set at 50 percent above normal line pressure operation downstream of shut-off or check valve required at each pressure regulator.
 4. Provide vacuum relief valves at medical vacuum pumps where indicated on the Drawings and required by NFPA 99.
 5. Provide automatic drain valves at medical air compressors where indicated on the Drawings and required by NFPA 99.
- B. Install zone valves in valve box anchored to structure. Install valves at angle that prevents closure of cover when valve is in closed position. A single box may be used for multiple valves when valves serve same area or same function.

3.07 HANGERS AND SUPPORTS

- A. General: Hanger, support, insulation protection shield and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.
- B. Pipe Attachments: Install the following:
1. Copper plated adjustable band swivel ring type hangers, MSS SP-69 Type 10, for copper tube for individual horizontal runs.
 2. Copper plated piping riser clamps, MSS SP-69 Type 8, for individual vertical runs.
 3. Copper coated extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of copper tube 2" and smaller on walls, or for securing copper tube inside walls and chases, or for supporting copper tubing above the floor with pipe supports attached to the floor with anchor bolts. Secure clamp to the copper tube.
 4. Support copper tube in chases and walls at wall outlets with plastic or copper brackets secured to structure and plastic coated U-bolts sized to bear on the pipe.
 5. Engineered strut support system may be provided, at the contractor's option, in lieu of individual hangers for horizontal pipes as specified in Division 22 "Hangers and Supports

for Plumbing Piping". Provide two piece straps secured to the bare pipe and provide plastic galvanic isolators for bare copper tube.

- C. Install hangers for horizontal piping with the following maximum spacing and minimum rod sizes:

<u>Nom. Pipe</u> <u>Size - In.</u>	<u>Copper Tube</u> <u>Max. Span - Ft.</u>	<u>Min. Rod</u> <u>Dia. - In.</u>
1/4	5	3/8
3/8	6	3/8
1/2	6	3/8
3/4	6	3/8
1	6	3/8
1-1/4	6	3/8
1-1/2	10	3/8
2	10	3/8
2-1/2	10	3/8
3	10	3/8
4	10	3/8
5	10	1/2
6	10	1/2

1. Support vertical copper tube at each floor and at intervals not to exceed 15 feet.
- D. Support copper tubing within 12" of each elbow or tee and for tubing 2-1/2" and larger at each valve.
- E. Provide vibration isolation for piping connected to rotating equipment. Vibration isolators are specified in Division 22 specification Section "Vibration Isolation for Plumbing Piping and Equipment".

3.08 CONNECTIONS

- A. General: Install valves that are same size as the piping connecting the equipment.
- B. Where medical gas piping to source equipment connections are dissimilar metals, install dielectric unions for joints 2" and smaller and install dielectric flanges for joints 2-1/2" and larger. Dielectric unions and flanges are specified in Division 22 Section "Basic Piping Materials and Methods." Provide unions or flanges downstream of shutoff valves. Provide unions or flanges upstream of shutoff valves for vacuum.
1. Install flexible pipe (tubing) connectors on air tubing connections to medical air compressors, vacuum tubing connections to medical vacuum pumps, and where indicated. Flexible tube connectors are specified in Division 22 Section "Basic Piping Material and Methods".
 2. Install thermometers on medical air compressor discharge tubing, medical air receiver tanks, medical vacuum receiver tanks, and where indicated. Thermometers are specified in Division 22 Section "Meters and Gauges for Plumbing Piping."
 3. Install pressure gauges on medical air compressor discharge tubing, air receiver tanks, vacuum receiver tanks, and where indicated. Pressure gauges are specified in Division 22 Section "Meters and Gauges for Plumbing Piping."
- C. Electrical wiring and connections are specified in Division 26 section "Common Work Results for Electrical".

3.09 EQUIPMENT INSTALLATION:

- A. General: Install medical air compressor and vacuum pump per the manufacturer's published recommendations. Install units plumb and level, firmly anchor to the locations indicated, and maintain manufacturer's clearances.
- B. Supports: Install packaged units on a 4" high concrete housekeeping pad, 4" larger than the outside dimension of the base. Mount units on concrete inertia bases.

- C. Electrical wiring: Install devices furnished by the manufacturer, but, not specified to be factory installed. Furnish a copy of wiring diagram submittal to the Electrical Contractor. Verify that electrical wiring installation is in accordance with the manufacturer's submittal requirements. Do not proceed with equipment start-up until wiring installation is acceptable to the equipment manufacturer's representative.
- D. Equipment Connections: Provide connections to the medical air and vacuum systems as indicated and comply with the equipment manufacturer's instructions. Install valves that are same size as the piping connecting the equipment. Install tubing and piping adjacent to equipment to allow servicing and maintenance.
 - 1. Air Compressor Air Intake: Comply with equipment manufacturer's sizing requirements and NFPA 99 clearance requirements.
 - 2. Vacuum Pump Exhaust: Comply with equipment manufacturer's sizing requirements and NFPA 99 clearance requirements.
- E. Testing and Start-up: The equipment manufacturer's representative shall conduct factory tests and inspect installation. The equipment manufacturer's representative shall provide to the architect documentation that the equipment installation meets factory installation requirements and that the equipment performance meets factory specifications.

3.10 ACCESSORIES INSTALLATION

- A. Install accessories in accordance with NFPA 99 and manufacturer's printed installation instructions

3.11 ALARM SYSTEM INSTALLATION

- A. General: Install alarm system components in accordance with NFPA 99 and manufacturer's printed installation instructions.
- B. Install alarm panels in locations indicated.
- C. Electrical wiring and connections are specified in Division 26 section "Common Work Results for Electrical".
- D. Coordinate interlock of air compressor and vacuum pump high temperature alarms with building automation system. Alarm wiring and alarm interlock with the building automation system are specified in Division 23 Section "Direct-Digital Control for HVAC".

3.12 LABELING AND IDENTIFICATION

- A. Install labeling on tubing, valves, valve box covers, and alarm panels in accordance with requirements of NFPA 99 (e.g. every 20 feet, per room, per each side of wall and per floor.). Refer to Division 22 Section "Identification for Plumbing Piping and Equipment" for piping within building, tubing, valves, gauges, alarms, and accessories.
- B. Captions and Color Coding: Use the following or similar medical gas captions and color coding for accessories, when specified and where required by NFPA 99.
 - 1. Oxygen: White letters on green background.
 - 2. Medical Air: Black letters on yellow background.
 - 3. Medical Vacuum: Black letters on white background.
- C. Where supplementary color identification of piping is used, it shall be in accordance with the gases and colors indicated in CGA Pamphlet C-9, "Standard Color-Marking of Compressed Gas Cylinders Intended for Medical Use."
- D. Label medical gas distribution systems operating at other than standard pressure with system operating pressure.
- E. Medical gas valve tags shall meet NFPA 99 requirements.

3.13 FIELD QUALITY CONTROL

- A. Installer Pre-Test: Perform odor test on all medical gas piping and outlet batches prior to installation to ensure that no objectionable odors exist.

- B. Installer Testing: Prior to declaring the medical gas system ready for final verification and certification, follow the procedures for verification as indicated in NFPA 99 and ASSE 6010 and can confirm that the following standard has been met:
1. System Clearing: Purge medical gas system tubing using oil-free dry air or nitrogen after installation of tubing but before installation of service outlet valves, alarms, and gauges.
 2. Pressure Test: Subject each section of each system to test pressure from 150 psig to 200 psig with oil-free dry air or nitrogen before attachment of system components, after installation of station outlets with test caps (when supplied) in place, and before concealing piping system. Maintain test until joints are examined for leaks by means of soapy water.
 3. Cross Connection Test: Determine that each outlet is connected to the appropriate line by flowing gas through each system. Test one system at a time using nitrogen.
 4. Initial Piping Purge Test: High flow through assembled outlets.
 5. Standing Pressure Test: Install assembled system components after testing individual systems as specified above. Subject systems to 24-hour standing-pressure test at 20 percent above normal line pressure but not less than 66 psig. Subject vacuum system to 12 to 18 inches of mercury minimum vacuum in lieu of pressure test. Test shall be witnessed by AHJ or Designee.
 6. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.
 7. Repair medical gas systems and replace components that fail tests specified.
 8. Provide to the engineer a completed copy of "Medical Gas System Installer Performance Testing Record" (or similar report) as found at the end of this specification section once all requirements of NFPA 99 and ASSE 6000 series have been met.
- C. Inspector Performance Requirements: The inspector shall perform all the required duties as indicated in ASSE 6000 Series including but not limited to:
1. Inspector's log: Maintain a log that contains records of site observations and test results required for inspectors.
 2. Test and inspection reports: The inspector shall personally witness the various tests and record the results of the tests performed by the installer as require.
 3. The inspector shall verify that the following documents are on file at the jobsite: Building permit, shop drawings, manufacturer's literature and data, manufacturer assembly test documentation for each manufacturer's unit, copper tubing and fittings cleaned for oxygen service documentation, brazing alloy documentation, purge and test gas documentation, qualification of brazing procedure specification, brazer performance qualification record, and qualification of welding procedures and welders if used, medical gas system installer certifications to ASSE Standard 6010 for each medical gas system installer, Medical Gas Systems Verifier certification to ASSE Standard 6030, and bulk medical gas system installers certifications to ASSE Standard 6015.
 4. The medical gas systems inspector shall confirm the following: Use of proper piping materials and joining methods, proper handling and installation of materials including supports, brazed piping purged with nitrogen NF while being brazed and capped or plugged during the installation process, welding piping purged with shield gas while being welded and capped or plugged during the installation process, labeling and identification, installation of manifolds, installation of bulk medical gas supply sources, installation of medical compressed air source equipment, and installation of medical vacuum source equipment, installation of alarm panels.
 5. The medical gas systems inspector shall verify the test reports for the following: Visual inspection of brazed and welded joints, inspection of all welded test coupons, initial piping blow-down, initial pressure test, initial cross-connection test, standing pressure test, standing vacuum test, initial piping purge test.

6. The medical gas systems inspector shall obtain a copy of the final system verification report performed in accordance with ASSE 6000 Series.
7. The medical gas systems inspector report data shall include:
 - a. Medical gas systems inspector identification
 - b. Medical gas systems inspector signature
 - c. Date of test
- D. Verifier Testing: Once the Installer Checklist is complete, the following is the general list of items per ASSE 6000 Series that the Medical Gas Verifier is to certify, including but not limited to the following:
 1. Prepare Test Equipment: All pressure/vacuum gauges, flow meters, adapters, medical gas analyzers, and other test equipment shall be medical gas clean, calibrator, and meet all other requirements of ASSE 6000 series.
 2. Standing pressure and vacuum tests: Verify that the distribution piping for positive pressure and vacuum medical gases is still free from leaks since being leak tested by the installer.
 3. Cross-connection Test (by individual pressurization or pressure differential: Verify that no cross-connections exist within any of the medical gas, instrument air, vacuum distribution and WAGD systems.
 4. Shut-off valve test: Verify that all shut-off valves in a medical gas and vacuum system function properly and are properly labeled.
 5. Master, area, and local alarm test: Verify that master, area, and local alarm systems function properly and are properly labeled.
 6. Piping purge test: Purge particulate matter from all positive pressure pipelines after construction.
 7. Piping particulate test: Verify the cleanliness of each positive –pressure medical gas piping system.
 8. Piping Purity test: Verify that the pressurized patient medical gas distribution systems are not contaminated by excessive water vapor (pressure dew point), total hydrocarbons (as methane) and halogenated hydrocarbons.
 9. Final tie-in test: Establish test procedures for verifying that where tie-ins are made to existing medical gas and medical support gas piping systems, the outlets downstream from the tie-in, in both the new and the existing piping are ready for acceptance by the AHJ or responsible facility authority.
 10. Operational pressure test: Verify that the decreases in line pressure or vacuum are not excessive with prescribed flow rates at the outlets and inlets.
 11. Medical gas concentration test: Verify that the proper concentration of system gas is present at each medical gas outlet after the test gas (nitrogen NF); is purged from the distribution piping. After thorough purging of all test gas, the required concentration of the specific system gases at each outlet shall per ASSE 6030 Table 1 (values as follows):
 - a. Oxygen: equal to or greater than +99%
 - b. Nitrous oxide: equal to or greater than +99%
 - c. Nitrogen: equal to or greater than +99% nitrogen or equal to or less than 1% oxygen.
 - d. Synthetic Medical Air USP 19.5% to 23.5% oxygen
 - e. Compressed Medical Air USP: equal to or greater than 20.9% oxygen
 - f. Other gases: Concentration as specified by their labeling +/- 1%
 - g. CSA:
 - 1) Oxygen: 99%
 - 2) Medical Air: 19-23%

- 3) Nitrous Oxide: 95%
- 4) Nitrogen 99%
- 12. Medical air purity test for compressor systems: Verify that the medical compressed air source equipment is installed in accordance with the requirements of NFPA 99.
- 13. Labeling of system components: Verify the presence and correctness of the labeling for components of the medical gas and vacuum distribution system (e.g. distribution piping, station outlets and inlets, shut-off valves, pressure gauges, alarm panels, etc.)
- 14. Medical gas supply source tests: Verify that medical gas supply manifolds changeover properly to a secondary and/or reserve supply and that proper alarms and indications are received in the master alarm systems.
- 15. Medical air compressor system tests: Verify the quality of medical air from systems utilizing on-site air compressors as the source.
- 16. Medical/surgical vacuum system tests: Verify that the medical vacuum source equipment is installed in accordance with the requirements of NFPA 99
- 17. Bulk medical gas supply system tests: Verify that the bulk medical gas supply system is communicating with the facility's master alarm system for medical gases and that the facility can monitor the bulk medical gas supply.
- E. The medical gas system verifier shall provide their own nitrogen test gas. If the Verifier does not have their own nitrogen purge gas, the Verifier may, at their own expense, purchase nitrogen from the medical gas installer.
- F. The General Contractor shall provide the engineer the results of tests.
- G. Provide the Owner an operational and functioning medical gas system with all certifications, test reports, observation reports, etc. without qualifications.

3.14 COMMISSIONING

- A. Provide the services of a factory-authorized service representative to inspect alarm system installation and to provide start-up service.
- B. Operate and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment discovered by the service representative.
- C. Checks before Start-up: Perform the following final checks before start-up:
 - 1. Verify that specified tests of piping systems are complete.
 - 2. Check that safety (pressure-relief) valves have correct setting that is greater than medical air compressor discharge pressure, but not greater than pressure rating of system components.

3.15 DEMONSTRATION

- A. Provide the services of a factory-authorized service representative to demonstrate alarm system start-up and shut-down procedures, preventative maintenance and servicing procedures, and troubleshooting procedures. Review operating and maintenance information.
- B. Provide 7-day written notice in advance of demonstration.

END OF SECTION 22 61 00

MEDICAL GAS SYSTEM INSTALLER PERFORMANCE TESTING RECORD

Testing is done per the requirement of ASSE standard 6010 and NFPA 99. All installer testing shall be performed by certified medical gas installers. The test gas used shall be nitrogen. In Canada: the test gas shall be oil-free dry air or oil-free dry nitrogen.

FACILITY NAME: _____
Project Manager: _____
Test Date: __/__/____ Start Time: __:__ AM/PM

AREA: _____
Job Foreman: _____
End Time: __:__ AM/PM

Medical Gas Installer: _____
Medical Gas Brazier: _____
O2 Analyzer: _____
Systems Certifications: _____

Certification Number: _____
Certification Number: _____
Certification number: _____

1. Initial Blow Down Test
 - a. Intermittent flow of nitrogen NF through piping.

Medical Gas System	Date	Tested By	Pass/Fail	Test Accepted By
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Oxygen

Medical Air

Nitrous Oxide

Carbon Dioxide

Nitrogen

Instrument Air

Medical/Surgical Vacuum

WAGD

2. Initial Pressure Test (Joints/Pipe Integrity)
 - a. Pressure test of 1-½ times the working pressure, 1035 kPa (150 psig) minimum, nitrogen at 1655 kPa (240 psig) minimum using nitrogen.

Medical Gas System	Date	Tested By	Pass/Fail	Test Accepted By
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Oxygen

Medical Air

Nitrous Oxide

Carbon Dioxide

Nitrogen

Instrument Air

3. Initial Pressure Test for Vacuum Systems

- a. Pressure test of 1035 kPa (150 psig) minimum using nitrogen.

Medical Gas System	Date	Tested By	Pass/Fail	Test Accepted By
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Medical/Surgical Vacuum

WAGD

4. Cross-Connection Test (Initial)

- a. Determine that each outlet is connected to the appropriate line by flowing gas through each system. Test on system at a time using nitrogen.

Medical Gas System	Date	Tested By	Pass/Fail	Test Accepted By
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Oxygen

Medical Air

Nitrous Oxide

Carbon Dioxide

Nitrogen

Instrument Air

Medical/Surgical Vacuum

WAGD

5. Initial Piping Purge Test

- a. High flow through assembled outlets.

Medical Gas System	Date	Tested By	Pass/Fail	Test Accepted By
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Oxygen

Medical Air

Nitrous Oxide

Carbon Dioxide

Nitrogen

Instrument Air

Medical/Surgical Vacuum

WAGD

6. Standard Pressure Test for Positive Pressure Piping

- a. Twenty-four (24) hour standing pressure test at 20% above normal line pressure using nitrogen NF with outlets and other components assembled.

Medical Gas System	Date	Tested By	Pass/Fail	Test Accepted By
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Oxygen

Medical Air

Nitrous Oxide

Carbon Dioxide

Nitrogen

Instrument Air

7. Standing Pressure Test for Vacuum Systems

- a. Twenty-four (24) hour standing vacuum test at 300 mm (12 inches) gauge HgV with inlets and other components assembled.

Medical Gas System	Date	Tested By	Pass/Fail	Test Accepted By
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Medical/Surgical Vacuum

WAGD

SECTION 23 00 10 GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.01 DESCRIPTION OF WORK

- A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.
- B. Division 23 of the Specifications and Drawings numbered with prefixes M, MP or ME, or MEP generally describe these systems, but the scope of the Mechanical work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, ductwork, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.02 QUALITY ASSURANCE

- A. All work under this Division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturers' requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.03 CODES, REFERENCES AND STANDARDS

- A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.
- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.
- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

BOCA	Building Officials Code Administration
UBC	Uniform Building Code
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code
IBC	International Building Code
IMC	International Mechanical Code
IPC	International Plumbing Code
IECC	International Energy Conservation Code
IFC	International Fire Code
IFGC	International Fuel Gas Code
ADA	American Disabilities Act
ADC	Air Diffusion Council
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
AHRI	Air Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Electrical Testing Laboratories
FGI	Guidelines for Design and Construction of Hospital and Healthcare Facilities
HI	Hydraulic Institute
MSS	Manufacturer's Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturers' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
UL	Underwriter's Laboratories

- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. All mechanical work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the mechanical work shall be provided by the Contractor.

1.04 DEFINITIONS

A. General:

1. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."
2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."

4. **Furnished by Owner or Furnished by Others:** The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
 5. **Engineer:** Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
 6. **AHJ:** The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
 7. **NRTL:** Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
- C. The following definitions apply to excavation operations:
1. **Additional Excavation:** Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
 2. **Bedding:** Bedding as used in this section refers to the compacted sand or pea gravel installed in the bottom of a trench to immediately support and cover a pipe or duct.
 3. **Subbase:** as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
 4. **Subgrade:** as used in this Section refers to the compacted soil immediately below the slab or pavement system.
 5. **Unauthorized excavation** consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.
 6. **Building Fill:** Building fill as used in this section refers to borrowed fill material of rock 1" and larger used to fill foundation excavations

1.05 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.
- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.
- C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The contractor shall locate equipment,

components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The contractor shall inform the architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.

- D. The Contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.
- E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the mechanical systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.
- F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.
- G. The mechanical contractor is responsible to the general contractor for the shop drawing layout of the following rooms and details. Prior to construction, contractor shall submit shop drawings of the following to Design Engineer for review.
 - 1. Concrete pads and foundations.
 - 2. Equipment room layouts with actual equipment, piping and duct.
 - 3. Roof layouts.
 - 4. Trench locations and sizes.
 - 5. Dimensioned floor drain locations.
 - 6. Congested areas (i.e. above ceilings adjacent to powerhouse or equipment rooms, etc.).

H.

1.06 MEASUREMENTS AND LAYOUTS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.07 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements, in addition to requirements specified herein.
- B. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- C. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in Table 1 at the end of this Section. Provide the number of submittals required by Division 01; if hard-copy sets are provided, submit a minimum of seven (7) sets. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

- D. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- E. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- F. Refer to individual Sections for additional submittal requirements.
- G. Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time, plus to/from mailing time via the Architect, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.
- H. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- I. The checking and subsequent acceptance by the Engineer and/or Architect of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Architect prior to implementing any deviation.

1.08 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.09 SUBSTITUTIONS

- A. Refer to Division 01 and General Conditions for Substitutions and Hospital preferred vendors.
- B. Materials, products, and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. No substitutions will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids. Each such request shall include the name of the material or equipment for which substitution is being requested, and a complete description of the proposed substitution including drawings, cut sheets, performance and test data, and all other information necessary for an evaluation. Include a statement setting forth changes in other materials, equipment or other work that incorporation of the substitution would require. The burden of proof of the merit of the proposed substitution is upon the proposer. The Engineer's decision to approve or disapprove a substitution in a Bid is final.
- D. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
- E. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.10 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals and record drawing requirements.

1.11 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections in Division 23 of this specification. Refer to Table 2 at the end of this Section for a list of specification sections in Division 23 that contain spare parts requirements.
- B. Owner or Owner's representative shall initial and date each section line in Table 2 when the specified spare parts for that section are received and shall sign at the bottom when all spare parts have been received.

1.12 RECORD DRAWINGS

- A. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.
- B. Refer to Division 01 and General Conditions for Record Drawings

1.13 TRAINING

- A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video record the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.14 PAINTING

- A. Paint the following work where exposed in equipment rooms and outside the conditioned building envelope refer to division 9 for additional instructions and requirements:
 - 1. uninsulated metal piping;
 - 2. uninsulated plastic piping;
 - 3. pipe hangers and supports;
 - 4. tanks that do not have factory-applied final finishes;
 - 5. duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material;
 - 6. equipment, stands, supports, intake bonnets, flutes, and all factory-primed items to receive final paint that are exposed to view in equipment rooms, on the roof or outside the building.
 - 7. Exposed galvanized sheetmetal installed outside of the conditioned building envelope, including in mechanical spaces that are heated only, is not required to be painted but shall be coated to prevent rust and corrosion.
- B. Paint the following work where exposed in occupied spaces:
 - 1. uninsulated metal piping;
 - 2. uninsulated plastic piping;
 - 3. pipe hangers and supports;
 - 4. duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material;
 - 5. other items as directed by Architect;
 - 6. equipment, stands, supports, intake bonnets, flutes and all factory-primed items to receive final paint that are exposed to view in equipment rooms, on the roof or outside the building.

- C. Mechanical piping in mechanical rooms, boiler rooms, and powerhouses shall be color codes to indicate service. See HCA Piping Color Table below for recommended color scheme. For work in existing facilities, contractor is to match existing color scheme.

HCA Piping Color Table	
Piping	Color Description
Low Temp Supply	Dark Purple
Low Temp Return	Light Purple
Chilled Water Supply	Dark Blue
Chilled Water Return	Light Blue
Condenser Water Supply	Bright Green
Condenser Water Return	Dark Green
Hot Water Supply	Bright Red
Hot Water Return	Dark Red
Condensate	Dark Orange
Steam	Bright Orange
Natural Gas	Bright Yellow
Fuel Oil	Brown
Domestic Water	Blue

- D. All piping, except for medical gas, shall be painted in exposed areas and in unconditioned areas such as loading docks, parking garages, canopies, and exterior soffits. Coordinate with architect to specify properly. Deletion of painting is not an allowable VE.

1.15 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling.
- B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.
- D. The Contractor shall be responsible for the safe storage of his own tools, material and equipment.

1.16 GUARANTEES AND WARRANTIES

- A. Refer to Division 01 and General Conditions for Guarantees and Warranties.
- B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.

- C. The following additional items shall be guaranteed:
 - 1. Piping shall be free from obstructions, holes or breaks of any nature.
 - 2. Insulation shall be effective.
 - 3. Proper circulation of fluid in each piping system.
- D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.
- E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.
- F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term. Refer to Table 3 at the end of this section for a list of specification sections in Division 23 that contain special warranties.

1.17 PROJECT CONDITIONS

- A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:
 - 1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting his bid to determine the nature and extent of work involved.
 - 2. Work in the existing building shall be scheduled with the Owner.
 - 3. Certain demolition work must be performed prior to the remodeling. The Mechanical Contractor shall perform the demolition which involves Mechanical systems, equipment, piping, equipment supports or foundations and materials.
 - 4. Mechanical Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Mechanical Contractor during this demolition shall become his property and shall be removed by the Mechanical Contractor from the premises and dispose of them in accordance with applicable federal, state and local regulations.
 - 5. Mechanical Contractor shall relocate and reconnect Mechanical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Mechanical equipment or materials are removed, the Mechanical Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.
 - 6. General Contractor shall install finish material.
 - 7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
 - 8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 - 9. Locate, identify, and protect mechanical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Conditions Affecting Excavations: The following project conditions apply:
 - 1. Maintain and protect existing building services which transit the area affected by selective demolition.
 - 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
- C. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.

- D. Use of explosives is not permitted.
- E. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

2.01 SOIL MATERIALS

- A. Bedding Material: Provide clean sand, pea gravel or flowable fill material (per the geotechnical or structural engineer's recommendations).
- B. Subbase Material: Where applicable, provide natural soils with 10% by volume of rocks less than 2" diameter or artificially graded crushed aggregate. Corrosive fill materials shall be not be utilized. When CL clay, rock, or gravel is used, it shall not be larger than 2 inches in any dimension and shall be free of debris, waste, frozen materials, vegetable and other deleterious matter.
- C. Drainage Fill: Provide washed, evenly graded mixture of 3/4" open graded aggregate stone or gravel, around drainage pipes to a level above pipe as detailed by Architect. Provide open graded aggregate, crushed stone, crushed or uncrushed gravel with 100 percent passing a 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve for drainage fill to subgrade or around equipment structures.
- D. Filter Fabric: Flat needle punched PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.

PART 3 - EXECUTION

3.01 PERMITS

- A. Secure and pay for permits required in connection with the installation of the Mechanical Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.02 EXISTING UTILITIES

- A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.
- B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.
- C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.
- D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.
- E. Contractor shall include in his bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.03 SELECTIVE DEMOLITION

- A. Refer to Division 02 and General Conditions for Selective Demolition requirements.
- B. General: Demolish, remove, demount, and disconnect abandoned mechanical materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- C. Materials and Equipment to Be Salvaged: Remove, demount, and disconnect existing mechanical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

- D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- E. Mechanical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls, and insulation.
 - a. Piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.
 - b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 23.
- F. Provide schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
 - 1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

3.04 EXCAVATION AND BACKFILLING

- A. Refer to Division 01, Division 02, and Division 31, Geotechnical Soils Report and General Conditions for Excavation and Backfilling
- B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this Division. Excavation and Trenching shall be in conformance with applicable Division and section of the General Specifications.
- C. Roads, alleys, streets and sidewalks damaged during this work shall be restored to the satisfaction of Authorities Having Jurisdiction.
- D. Trenches close to walks or columns shall not be excavated without prior consultation with the Architect.
- E. Erect barricades around excavations and trenches for safety. Provide an adequate number of amber lights on or near the work and keep them burning from dusk to dawn. Contractor shall be held responsible for any damage that any parties may sustain due to neglecting the necessary precautions when performing the work.
- F. Slope sides of excavations and trenches to comply with Geotechnical Report, local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.
- G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations and trenches regardless of time period excavations and trenches will be open.
 - 1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
- H. Install sediment and erosion control measures in accordance with local codes and ordinances.
- I. Dewatering of Excavation and Trenches: Prevent surface water and subsurface or ground water from flowing into excavations and trenches.
 - 1. Do not allow water to accumulate in excavation or trenches. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations and trenches.
 - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation and trench limits to convey surface water to collecting or run-off areas.
 - 3. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.
- J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations and trenches. Do not store within drip-line of trees indicated to remain.
 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
- K. Excavation for Underground Tanks, Basins, and Mechanical Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- L. Trenching: Excavate trenches as follows:
1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of pipe and equipment.
 2. Excavate trenches to depth indicated or required to establish indicated slope and invert elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
 3. Limit the length of open trench to that in which pipe can be installed, tested, and the trench backfilled within the same day.
 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of sand or pea gravel prior to installation of pipe. Provide a minimum of 6 inches of sand or pea gravel cushion between rock bearing surface and pipe.
 5. Excavate trenches for piping and equipment with bottoms of trench to accurate elevations for support of pipe and equipment bedding on undisturbed soil.
- M. Cold Weather Protection: Protect excavation and trench bottoms against freezing when atmospheric temperature is less than 35°F.
- N. Bedding:
1. Fill bottom of pipe trench and fill unevenness with compacted bedding material to ensure continuous bearing of the pipe barrel on the bearing surface. Additional bedding installation requirements are in the following piping specifications. Compact bedding as described below.
 2. Fill bottom of equipment trench and fill unevenness with compacted sand backfill to ensure continuous bearing of the equipment on the bearing surface. Compact bedding as described below.
- O. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
1. Under pipes, use bedding materials in layers to 6 inches above top of the pipe.
 2. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 3. Under building slabs, use subbase materials.
 4. Under piping and equipment, use bedding and subbase materials over rock bearing surface and for correction of unauthorized excavation.
 5. For piping less than 30 inches below surface of roadways, provide 4-inch-thick concrete protection slab. After installation and testing of pipes, provide a 4-inch thick concrete protection top slab prior to backfilling and placement of roadway subbase. Contractor shall coordinate with local AHJ as to requirements for colored concrete in this application.
 6. Other areas, use excavated or borrowed materials where applicable.

7. Backfill excavations as promptly as work permits, but not until completion of the following:
 - a. Inspection, testing, approval, and locations of underground utilities have been recorded.
 - b. Removal of concrete formwork.
 - c. Removal of shoring and bracing, and backfilling of voids.
 - d. Removal of trash and debris.
8. Where gravel fill (drainage fill) is used as building fill material in lieu of natural soils, provide filter fabric material to line the trench to support the bedding fill material and subgrade materials to ensure that backfill materials will not segregate within the trench nor create voids and sags within the pipe trench.
9. Ductwork under slab shall be backfilled with a minimum of 4" bedding material on all sides for protection from soils (per Code). Subbase materials shall be utilized above the bedding material to the subgrade level.
 - a. If concrete encasement is required, a minimum of 4" thickness all sides shall be provided unless otherwise noted. Contractor shall provide hold down straps as per manufacturer's recommendations.
 - b. If a concrete ballast pad is required, size of ballast pad shall be as noted on the drawings or as per manufacturer's recommendations.
- P. Backfill excavations as promptly as work permits, but not until completion of the following:
 1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 2. Removal of concrete formwork.
 3. Removal of shoring and bracing, and backfilling of voids.
 4. Removal of trash and debris.
- Q. Subgrade Placement and Compaction: Place subgrade backfill materials in maximum layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- R. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- S. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of piping and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- T. Placement and Compaction: Place bedding backfill materials in maximum layers of not more than 6 inches loose depth for material compacted by hand-operated tampers. Place subbase backfill materials in maximum layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.
 1. Use of pneumatic backhoe as compaction method is disallowed as an acceptable process for compaction of excavations or trenches.
 2. For vertical and/or diagonal pipe installations greater than 1/2" rise/lf, thoroughly support pipes from permanent concrete structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that pipes are not deflected, crushed, broken, or otherwise damaged by the backfill placement or settlement.
 3. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

4. Place backfill and/or drainage fill materials evenly adjacent to structures, piping, and equipment to required elevations. Coordinate with Architect and/or Civil Engineer backfill requirements prior to installation. Prevent displacement of pipes and equipment by carrying material uniformly around them to approximately same elevation in each layer or lift.
5. Compaction: control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:
6. Percentage of maximum density requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 or ASTM D 698 and not less than the following percentages of relative density, determined in accordance with ASTM D 4253, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
 - a. Areas under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 95 percent maximum density for cohesive material listed, or 95 percent relative density for cohesionless material.
 - b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 95 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - c. Other Areas: Compact top 6 inches of subgrade and each layer of subbase backfill or fill material to 90 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
- U. Subsidence: Where subsidence occurs at mechanical installation excavations and trenches during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.05 CUTTING AND PATCHING

- A. The Contractor shall do necessary cutting of walls, floors, ceilings and roofs.
- B. No structural member shall be cut without permission from Architect.
- C. Patch around openings to match adjacent construction.
- D. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

3.06 CLEANING

- A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Mechanical Contractor shall cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to the final inspection, the Mechanical Contractor shall clean material and equipment installed under the Mechanical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.07 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:
 1. Submit complete Operation and Maintenance Manuals.
 2. Submit complete Record Drawings.
 3. Perform special inspections. Refer to Table 4 at the end of this section for a list of specification sections in Division 23 that contain special inspection requirements.
 4. Start-up testing of systems.
 5. Removal of temporary facilities from the site.

6. Comply with requirements for Substantial Completion in the "General Conditions".
- B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.
 - C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.
 - D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.
 - E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, He shall reimburse the Architect/Engineer for time and expenses incurred for the visit.
 - F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
 - G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
 - H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. He shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 23 00 10

TABLE 1: MECHANICAL SPECIFICATION SHOP DRAWING SUBMITTAL REQUIREMENTS

SPECIFICATION NUMBER/TITLE		CODE DESIGNATION
230010	General Mechanical Requirements	NONE
230519	Meters and Gauges for HVAC Piping	B, H
230523	General-Duty Valves for HVAC Piping	B
230529	Hangers and Supports for HVAC Piping and Equipment	B, F, G, H
230553	Identification for HVAC Piping and Equipment	B, L, N
230593	Testing, Adjusting and Balancing For HVAC	H, J
230700	HVAC Insulation	B, L
230913	Instrumentation and Control Devices for HVAC	A, B, C, D, E, F, N, O, Q
230923	Direct-Digital Control for HVAC	A, B, C, D, E, F, J, K, L, N, O, Q
232113	Hydronic Piping	B, C, D, F, G, H, J
232116	Hydronic Specialties	A, B, C, F, G, H
232213	Steam and Condensate HVAC Piping	B, C, D, F, G, H, J
232216	Steam and Condensate Piping Specialties	A, B, C, F, G, H
233113	Metal Ducts	A, B, D, G
233300	Air Duct Accessories	A, B, F, Q
233415	Exhaust and Ventilating Fans	A, B, C, F
233600	Air Terminal Units	A, B, C, E, F
233713	Diffusers, Registers, and Grilles	A, B, C, F, M, N, Q
237413	Outdoor Central Station Air Handling Units	A, B, C, E, F, K, Q
238413	Humidifiers (Dispersion Type)	A, B, C, E, F

CODED LEGEND

A	Shop Drawings
B	Product Data
C	Performance Data, Capacities, Curves and Certificates
D	Coordination Drawings
E	Wiring Diagrams
F	Installation Instructions
G	Welder's Certificates
H	Certificates
I	Calculations
J	Test Reports
K	Special Warranties
L	Material Samples
M	Color Samples
N	Schedules
O	Equipment List
P	Material List
Q	Recommended Spare Parts List

TABLE 2: SPARE PARTS REQUIREMENTS FOR MECHANICAL EQUIPMENT

Section Number		Received/Date/Initial
230553	Identification for HVAC Piping and Equipment	_____
232116	Hydronic Specialties	_____
232216	Steam and Condensate Piping Specialties	_____
233300	Air Duct Accessories	_____
233415	Exhaust and Ventilating Fans	_____
233600	Air Terminal Units	_____
233713	Diffusers, Registers, and Grilles	_____
237413	Outdoor Packaged Heating and Cooling Units	_____

		Owner's Signature

TABLE 3: SPECIAL WARRANTY REQUIREMENTS FOR MECHANICAL EQUIPMENT

Section Number
Received/Date/Initial

230923	Direct Digital Control for HVAC	_____
237413	Outdoor Packaged Heating and Cooling Units	_____

TABLE 4: MECHANICAL SPECIFICATION OPERATION AND MAINTENANCE SUBMITTAL REQUIREMENTS

SPECIFICATION NUMBER/TITLE	CODE DESIGNATION
230514 Variable Frequency Drives	B, C, D, E, G, H, I
230519 Meters and Gauges for HVAC Piping	B, G, I
230529 Hangers and Supports for HVAC Piping and Equipment	B
230553 Identification for HVAC Piping and Equipment	B
230593 Testing, Adjusting and Balancing for HVAC	F
230700 HVAC Insulation	B
230913 Instrumentation and Control Devices for HVAC	A, B, C, D, E, G, H, I
230923 Direct-Digital Control for HVAC	A, B, C, D, E, F, G, H, I
232113 Hydronic Piping	A, B, C, F, G, H, I
232116 Hydronic Specialties	A, B, C, I
232213 Steam and Condensate HVAC Piping	A, B, C, F, G, H, I
232216 Steam and Condensate Piping Specialties	A, B, C, I
233113 Metal Ducts	A, B
233300 Air Duct Accessories	B, H
233416 Centrifugal HVAC Fans	B, C, G, I
233600 Air Terminal Units	B, C, D, E, G, H, I
233713 Diffusers, Registers and Grilles	C, H
237413 Outdoor Packaged Heating and Cooling Units	B, C, D, E, G, H, I
238413 Humidifiers (Dispersion Type)	B, C, D, E, G, H, I

CODED LEGEND

A	As-Built Drawings
B	Product Data
C	Performance Data, Capacities, Curves and Certificates
D	Wiring Diagrams
E	Operating Instructions
F	Test Reports
G	Warranties
H	Recommended Spare Parts List
I	Service and Maintenance Instructions

SECTION 23 05 19 METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Pressure gauges and fittings.
- B. Thermometers and thermometer wells.
- C. Test plugs.
- D. Filter gauges.

1.02 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
- B. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi; 2007.
- C. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014.
- D. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014.
- E. AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case; 2015.
- F. AWWA C701 - Cold-Water Meters -- Turbine Type, for Customer Service; 2012.
- G. AWWA C702 - Cold-Water Meters -- Compound Type; 2010.
- H. AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance; 2012.
- I. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.
- J. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.
- B. Product Data: Provide schedule that indicates the following for each manufactured component:
 - 1. Model or figure number.
 - 2. Use.
 - 3. Rating.
 - 4. Operating range.
 - 5. Total range.
 - 6. Calibrated performance curves, certified where indicated.
 - 7. Figure number.
 - 8. Location.
 - 9. Accessories.
- C. Product Certificates: Signed by manufacturer certifying accuracy under specified operating conditions and product compliance with specified requirements.
- D. Samples: Submit two of each type of instrument specified.
- E. Project Record Documents: Record actual locations of components and instrumentation.
- F. Operation and Maintenance Data: Furnish data for each manufactured component for inclusion in operating and maintenance manual.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Pressure Gauges: One of each type and size.

1.04 FIELD CONDITIONS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 - PRODUCTS

2.01 PRESSURE GAUGES

- A. Manufacturers:
 - 1. Ametek, U.S. Gauge Div.
 - 2. Ashcroft Dresser Industries Instrument Div.
 - 3. Dwyer Instruments, Inc.
 - 4. H.O. Trerice Co.
 - 5. Marsh Instrument Co., Unit of General Signal.
 - 6. Marshalltown Instruments, Inc.
 - 7. Miljoco Corp.
 - 8. Weiss Instruments, Inc.
 - 9. Weksler Glass Thermometer Corp.
 - 10. WIKA Instruments Corp.
 - 11. Winters Instruments.
- B. Description: ASME B40.100, UL 393, rotary brass movement, white with black markings and black pointer.
- C. Case: Drawn steel, cast aluminum, or stainless steel with phosphor bronze bourdon tube and front or rear recalibration adjustment. Provide silicone fluid damping where required by Part 3.
- D. Size: 4-1/2 inch diameter.
- E. Lens: Clear glass.
- F. Stem: Brass for separable socket, length to suit installation.
- G. Scale: Progressive, satin-faced, non-reflective aluminum, permanently etched markings.
- H. Accuracy: Plus or minus 1 percent of range span. Gauges in chiller room shall be ½% accuracy.
- I. Liquid-Filled: Provide glycerin liquid filled gauges in all mechanical rooms and where specified in Part 3 of this section.

2.02 PRESSURE GAUGE TAPPINGS

- A. Manufacturers: Same as pressure gauge manufacturers.
- B. Gauge Cock: Tee or lever handle, brass, rated for system pressure.
- C. Needle Valve: Brass, 1/4 inch NPT, rated for system pressure.
- D. Pulsation Damper: Pressure snubber, brass with 1/4 inch threaded connections, corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.
- E. Syphon: Brass, 1/4-inch NPT angle or straight pattern.

2.03 STEM TYPE THERMOMETERS

- A. Manufacturers:
 - 1. Weiss Instruments, Inc.
- B. Thermometers - Solar Digital Vari-Angle
 - 1. Case: High impact ABS with glass passivated thermistor, 3-1/2 inches long.
 - 2. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
 - 3. Display: 3/8" LCD digits, wide ambient formula, 10 lux, and -40°F to 300°F range. Provide with an accuracy of 1%.

4. Recalibration: Internal potentiometer.
5. Stem: Stainless steel, aluminum or brass, for separable socket, length to suit installation.
 - a. Minimum 6" stem where installed in air sensing applications.
6. Provide Weiss, DVU-35 with separable well or approved equal from listed manufacturer.

2.04 TEST PLUGS

- A. Manufacturers:
 1. Flow Design, Inc.
 2. MG Piping Products Co.
 3. Peterson Equipment Co., Inc.
 4. Sisco, A Spedco, Inc. Co.
 5. Watts Regulator.
- B. Test Plug: 1/2 inch nickel-plated brass fitting, rated for 500 psig, extension for insulation, and threaded cap with retention chain for receiving 1/8 inch outside diameter pressure or temperature probe.
- C. Core Material:
 1. Neoprene core for temperatures up to 200 degrees F.
 2. Nordel core for temperatures up to 350 degrees F.
 3. Viton core for temperatures up to 400 degrees F.
- D. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gauge, one gauge adapter with 1/8 inch probes, two 1 inch bimetal dial thermometers.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide siphon on gauges in steam systems. Extend nipples and siphons to allow clearance from insulation.
- C. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- D. Install thermometers in air duct systems on flanges.
- E. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Refer to Section 23 09 43. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
- F. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.
- G. Coil and conceal excess capillary on remote element instruments.
- H. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- I. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- J. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- K. Locate test plugs adjacent thermometers and thermometer sockets.

3.02 SYSTEM START-UP & COMMISSIONING

3.1 Operation & Maintenance

- A. Meter Data sheets, Installation Manual, and Operation Manual shall be included in the Operation and Maintenance (O&M) documents provided for each meter type.
- B. Demonstration of each meter type display is to be provided to the facility manager and his / her staff.

3.03

3.04 SCHEDULE

- A. Pressure Gages, Location and Scale Range:
 - 1. Location: Install device at inlet and outlet of each of the following:
 - a. Headers to central equipment.
 - b. Heat exchangers.
 - c. Pumps. Provide silicone damping gauge.
 - d. Boilers.
 - e. Chillers.
 - f. After major coils. Reference details on plans.
 - g. Expansion tanks.
 - h. Pressure reducing valves.
 - 2. Scale Range:
 - a. Vacuum: 30 inches Hg to 15 psig.
 - b. All fluids: 2 times operating pressure.
- B. Pressure Gage Tappings, Location:
 - 1. Control valves 3/4 inch & larger – inlets and outlets.
 - 2. Major coils – inlets and outlets.
 - 3. Heat exchangers – inlets and outlets.
 - 4. Chiller – inlets and outlets.
 - 5. Boiler – inlets and outlets.
- C. Stem Type Thermometers, Location and Scale Range:
 - 1. Location: Install device at inlet and outlet of each of the following:
 - a. Headers to central equipment.
 - b. Heat exchangers.
 - c. Boilers.
 - d. Chillers.
 - e. Hydronic zone supply and return.
 - f. After major coils. Reference details on plans.
 - g. Heat recovery unit
 - h. Thermal storage tank.
 - 2. Scale Range:
 - a. Hot Water: 30 to 300 degrees F with 2-degree scale divisions
 - b. Condenser Water: 0 to 160 degrees F with 2-degree scale divisions.
 - c. Chilled Water: 0 to 100 degrees F with 2-degree scale divisions.
 - d. Steam and Condensate: 50 to 400 degrees F with 5-degree scale divisions.
- D. Thermometer Sockets, Location:
 - 1. Control valves 1 inch & larger - inlets and outlets.
 - 2. Reheat coils - inlets and outlets.
 - 3. Cabinet heaters - inlets and outlets.

- 4. Unit heaters - inlets and outlets.
- E. Dial Thermometers, Location and Scale Range:
 - 1. Each supply air zone, minus 32 to 150 degrees F.
 - 2. Outside air, minus 32 to 150 degrees F.
 - 3. Return air, minus 32 to 150 degrees F.
 - 4. Mixed air, minus 32 to 150 degrees F.

END OF SECTION 23 05 19

SECTION 23 05 23 GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Applications.
 - 1. General duty valves common to most mechanical piping systems.
 - 2. Special purpose valves are specified in individual piping system specifications.
- B. General requirements.
- C. Globe valves.
- D. Ball valves.
- E. Butterfly valves.
- F. Check valves.
- G. Gate valves.
- H. Chainwheels.

1.02 ABBREVIATIONS AND ACRONYMS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene diene monomer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. PTFE: Polytetrafluoroethylene.
- G. RS: Rising stem.
- H. SWP: Steam working pressure.
- I. TFE: Tetrafluoroethylene.

1.03 SUBMITTALS

- A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.
- B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, pressure and temperature classifications, valve design, body material, seating materials, trim material, dimensions, clearances, rough-in details, weights, support requirements, and piping connections.
- C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.
- E. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.

1.04 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Obtain valves for each valve type from a single manufacturer.
 - 2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.
 - 3. Subject to compliance requirements, provide products from one of the manufacturers listed in Valve Schedule in Part 3.

- B. Valves shall be certified to meet the specified ASTM, ASME, ANSI, and MSS standards in Part 2 Products, and as follows:
 - 1. ASME B31.9 for building services piping.
 - 2. ASME B31.1 for power piping.
- C. Welding Materials and Procedures: Conform to ASME BPVC-IX.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
 - 2. Protect valve parts exposed to piped medium against rust and corrosion.
 - 3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
 - 4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
 - 5. Secure check valves in either the closed position or open position.
 - 6. Adjust butterfly valves to closed or partially closed position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection and protect flanges and specialties from dirt.
 - a. Provide temporary inlet and outlet caps.
 - b. Maintain caps in place until installation.
 - 2. Store valves in shipping containers and maintain in place until installation.
 - a. Store valves indoors in dry environment.
 - b. Store valves off the ground in watertight enclosures when indoor storage is not an option.
- C. Exercise the following precautions for handling:
 - 1. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide products from one of the manufacturers listed in the Valve Schedule in Part 3.

2.02 APPLICATIONS

- A. Provide the following valves for the applications if not indicated on Drawings:
 - 1. Throttling (Hydronic): Butterfly, Ball, and Globe.
 - 2. Throttling (Steam): Globe.
 - 3. Isolation (Hydronic): Butterfly, Gate, Ball, and Globe.
 - 4. Isolation (Steam): Gate and Ball.
 - 5. Dead-End: Butterfly and Ball.
- B. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.
- C. Required Valve End Connections for Non-Wafer Types:
 - 1. Steel Pipe:
 - a. 2 NPS and Smaller: Threaded ends.
 - b. 2-1/2 NPS and Larger: Grooved or flanged ends.
 - 2. Copper Tube:
 - a. 2 NPS and Smaller: Threaded or solder-joint valve ends.
 - 1) Exception: Solder ends not acceptable for hot water or steam pipe.

- b. 2-1/2 NPS and Larger: Grooved or flanged ends.
 - 3. Steam and Steam Condensate Pipe: Solder and grooved ends not acceptable.
- D. Chilled Water Valves:
 - 1. 2 NPS and Smaller:
 - a. Minimum Class: 125.
 - b. Body: Bronze.
 - c. Allowable Valve Types:
 - 1) Ball: Two piece.
 - 2) Lift check.
 - 3) Swing check.
 - 4) Wafer plate-type check.
 - 2. 2-1/2 NPS and Larger:
 - a. Minimum Class: 125.
 - b. Body: Cast iron, except as noted below.
 - c. Allowable Valve Types:
 - 1) Butterfly: Ductile iron body.
 - 2) Lift check.
 - 3) Swing check.
 - 4) Wafer plate-type check.
- E. Condenser Water Valves:
 - 1. 2 NPS and Smaller:
 - a. Minimum Class: 125.
 - b. Body: Bronze.
 - c. Allowable Valve Types:
 - 1) Ball: Two piece.
 - 2) Lift check.
 - 3) Swing check.
 - 4) Wafer plate-type check.
 - 2. 2-1/2 NPS and Larger:
 - a. Minimum Class: 125.
 - b. Body: Cast iron, except as noted below.
 - c. Allowable Valve Types:
 - 1) Butterfly: Ductile iron body. Furnish aluminum bronze or stainless steel disc in open loop systems.
 - 2) Lift check.
 - 3) Swing check.
 - 4) Wafer plate-type check.
- F. Heating Hot Water Valves:
 - 1. 2 NPS and Smaller:
 - a. Minimum Class: 125.
 - b. Body: Bronze.
 - c. Allowable Valve Types:
 - 1) Ball: Two piece.
 - 2) Lift check.

- 3) Swing check.
 - 4) Wafer plate-type check.
- 2. 2-1/2 NPS and Larger:
 - a. Minimum Class: 125.
 - b. Body: Cast iron, except as noted below.
 - c. Allowable Valve Types:
 - 1) Butterfly: Ductile iron body.
 - 2) Lift check.
 - 3) Swing check.
 - 4) Wafer plate-type check.
- G. Low Pressure Steam Valves (15 PSIG or Less):
 - 1. 2 NPS and Smaller:
 - a. Minimum Class: 150.
 - b. Body: Bronze.
 - c. Allowable Valve Types:
 - 1) Ball: Two piece, Class 250, 600 psig CWP.
 - 2) Lift check.
 - 3) Swing check.
 - 4) Wafer plate-type check.
 - 2. 2-1/2 NPS and Larger:
 - a. Minimum Class: 150.
 - b. Body: Cast iron, except as noted below.
 - c. Allowable Valve Types:
 - 1) Lift check.
 - 2) Wafer plate-type check.
 - 3) Gate.
- H. High Pressure Steam Valves (Greater than 15 PSIG):
 - 1. 2 NPS and Smaller:
 - a. Minimum Class: 200
 - b. Body: Bronze.
 - c. Allowable Valve Types:
 - 1) Swing Check.
 - 2) Gate.

2.03 GENERAL REQUIREMENTS

- A. Mechanically Joined General Duty Valves:
 - 1. Contractor may provide mechanically joined general duty valves as an option in lieu of, in whole of, or in part of, the general duty valve fitting and joining methods for the specific systems indicated in Article "Applications." Reference Division 23 Section "Mechanically Joined Hydronic Piping Systems."
 - 2. Contractor shall not use mechanically joined general duty valves for hydronic piping in lieu of welded, threaded or flanged valves.
- B. Ball Valves on reheat coils shall be provided with memory stops
- C. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- D. Valve Sizes: Match upstream piping unless otherwise indicated.

- E. Valve Stem Design:
 - 1. Rising stem or rising outside screw and yoke stems.
 - 2. Non-rising stem valves may be used on water systems where headroom prevents full extension of rising stems.
- F. Valve Actuator Types:
 - 1. Gear Actuator: Quarter-turn valves 8 NPS and larger.
 - 2. Handwheels: Valves other than quarter-turn types.
 - 3. Hand Lever: Quarter-turn valves 6 NPS and smaller, vinyl-covered.
 - 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- G. Valves in Insulated Piping: Provide stem extensions so valve operator extends a minimum of 1/2 inches outside of the insulation and the following features:
 - 1. Gate Valves: Rising stem.
 - 2. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 3. Butterfly Valves: Extended neck.
 - 4. Memory Stops: Fully adjustable after insulation is installed.
- H. Valve-End Connections:
 - 1. Threaded End Valves: ASME B1.20.1.
 - 2. Flanges: ASME B16.1 for cast iron.
 - 3. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5 for steel, ASME B16.24 for bronze.
 - 4. Solder Joint Connections: ANSI B16.18.
 - 5. Grooved End Connections: AWWA C606.
- I. General ASME Compliance:
 - 1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
 - 2. Power Piping Valves: ASME B31.1.
 - 3. Building Services Piping Valves: ASME B31.9.
- J. Bronze Valves:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- K. Valve Bypass and Drain Connections: MSS SP-45.
- L. Source Limitations: Obtain each valve type from a single manufacturer.

2.04 BRONZE GLOBE VALVES

- A. Class 150, 300 psig CWP:
 - 1. Comply with MSS SP-80, Type 2, nonmetallic disc to metal seat.
 - 2. Body: Bronze; ASTM B62, with integral seat and union bonnet.
 - 3. Ends: Threaded or solder joint.
 - 4. Stem and Disc: Bronze stem, PTFE disc.
 - 5. Packing: Asbestos free, brass gland.
 - 6. Operator: Malleable iron handwheel.

2.05 IRON GLOBE VALVES

- A. Class 125, 200 psig CWP and Class 250, 500 psig CWP: 2 1/2" and larger
 - 1. Comply with MSS SP-85, Type 1.

2. Body: Gray iron; ASTM A126, with bolted bonnet.
3. Ends: Grooved or flanged.
4. Trim: Bronze.
5. Packing and Gasket: Asbestos free, two-piece backing gland assembly.
6. Operator: Handwheel or chainwheel.

2.06 BRONZE BALL VALVES

- A. Two Piece, Class 150, for valves 2 inch and smaller:
 1. Comply with MSS SP-110.
 2. CWP Rating: 600 psi.
 3. Body: Bronze, ASTM B584.
 4. Trim: Bronze.
 5. Ends: Threaded or solder joint.
 6. Seats and Seals: PTFE.
 7. Stem: Blowout-proof.
 8. Ball: Full port, ASTM A276 Type 316 stainless steel.
 9. Operator: Vinyl-covered steel handle.

2.07 TWO PIECE, CLASS 250 VALVES

- A. Two Piece, Class 150, for valves 2 inch and smaller:
 1. Comply with MSS SP-110.
 2. SWP Rating: 250 psig.
 3. CWP Rating: 600 psig.
 4. Body: Bronze, ASTM B61.
 5. Trim: Bronze.
 6. Ends: Threaded.
 7. Seats and Seals: PTFE.
 8. Stem: Stainless steel, blowout-proof.
 9. Ball: Full port, ASTM A276 Type 316 stainless steel, vented.
 10. Operator: Vinyl-covered steel handle.
 - 11.

2.08 IRON BUTTERFLY VALVES

- A. Lug type: Bi-directional dead-end service without downstream flange.
 1. Comply with MSS SP-67, Type I.
 2. CWP Rating: 200 psig and 250 psig.
 3. Body Material: ASTM A536 ductile iron.
 4. Stem: One or two-piece stainless steel.
 5. Seat and Seal: EPDM.
 6. Disc: Aluminum-bronze, stainless steel, or one-piece Nylon-coated ductile iron.
 7. Operator:
 - a. Size less than 8 inches: Lever operator, 10 position minimum, with locks and stops.
 - b. Size 8 inch and larger: Gear type with position indicator.

2.09 BRONZE LIFT CHECK VALVES

- A. Class 150:
 1. Comply with MSS SP-80, Type 2, Nonmetallic Disc to Metal Seat.
 2. CWP Rating: 200 psig.

3. Design: Horizontal or angle pattern, capable of being refitted and ground while valve remains in the line.
4. Body: Bronze, ASTM B62.
5. Ends: Threaded.
6. Spring: Stainless steel.
7. Disc: PTFE.

2.10 BRONZE SWING CHECK VALVES

- A. Class 125:
 1. Comply with MSS SP-80, Type 3.
 2. CWP Rating: 200 psig.
 3. Design: Horizontal swing, Y-pattern, capable of being refitted and ground while valve remains in the line.
 4. Body: Bronze, ASTM B62.
 5. Ends: Threaded or solder joint.
 6. Disc: PTFE.
- B. Class 150:
 1. Comply with MSS SP-80, Type 3.
 2. CWP Rating: 300 psig.
 3. Design: Horizontal swing, Y-pattern, capable of being refitted and ground while valve remains in the line.
 4. Body: Bronze, ASTM B62.
 5. Ends: Threaded.
 6. Disc: PTFE.
- C. Class 200:
 1. Comply with MSS SP-80, Type 3.
 2. CWP Rating: 400 psig.
 3. Design: Horizontal swing, Y-pattern, capable of being refitted and ground while valve remains in the line.
 4. Body: Bronze, ASTM B61.
 5. Ends: Threaded.
 6. Disc: Bronze.

2.11 IRON, FLANGED END SWING CHECK VALVES

- A. Class 125, 200 psig CWP.
 1. Comply with MSS SP-71, Type I.
 2. Design: Horizontal swing, clear or full waterway, capable of being refitted and ground while valve remains in the line.
 3. Body: Cast iron with bolted bonnet in accordance with ASTM A126, Class B.
 4. Ends: Flanged.
 5. Trim: Bronze.
 6. Disc Holder: Bronze face ring and seat ring.
 7. Disc: Bronze or ductile iron.
 8. Gasket: Asbestos free.
- B. Class 250, 500 psig CWP.
 1. Comply with MSS SP-71, Type I.

2. Design: Horizontal swing, clear or full waterway, capable of being refitted and ground while valve remains in the line.
3. Body: Cast iron with bolted bonnet in accordance with ASTM A126, Class B.
4. Ends: Flanged.
5. Trim: Bronze.
6. Disc Holder: Bronze face ring and seat ring.
7. Disc: Bronze or ductile iron.
8. Gasket: Asbestos free.

2.12 IRON, WAFER PLATE-TYPE CHECK VALVES

- A. Class 125 Dual-Plate (Twin Disc):
 1. Comply with API STD 594.
 2. 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
 3. 14 NPS to 24 NPS, CWP Rating: 150 psig.
 4. Design: Wafer, non-slam, spring-loaded plates, designed to open and close at approximately 0.5 psi differential.
 5. Body: ASTM A126, cast iron.
 6. Ends: Flanged.
 7. Trim: Stainless steel.
 8. Disc: Replaceable bronze.
 9. Seat: EPDM, or NBR.
- B. Class 250 Dual-Plate (Twin Disc):
 1. Comply with API STD 594.
 2. 2-1/2 NPS to 12 NPS, CWP Rating: 400 psig.
 3. 14 NPS to 24 NPS, CWP Rating: 300 psig.
 4. Design: Wafer, non-slam, spring-loaded plates, designed to open and close at approximately 0.5 psi differential.
 5. Body: ASTM A126, cast iron.
 6. Ends: Flanged.
 7. Trim: Stainless steel.
 8. Disc: Bronze.
 9. Seat: EPDM, or NBR.

2.13 BRONZE GATE VALVES

- A. Class 150:
 1. Comply with MSS SP-80, Type I.
 2. CWP Rating: 300 psig.
 3. Body: Bronze, ASTM B61 with integral seat and union-ring bonnet.
 4. Trim: Bronze.
 5. Ends: Threaded.
 6. Stem: Bronze, RS type. NRS type where exceptions apply.
 7. Disc: Solid wedge; bronze.
 8. Packing: Asbestos free, brass.
 9. Operator: Malleable iron handwheel.
- B. Class 300:
 1. Comply with MSS SP-80, Type I.

2. CWP Rating: 600 psig.
3. Body: Bronze, ASTM B61 with integral seat and union-ring bonnet.
4. Trim: Bronze.
5. Ends: Threaded.
6. Stem: Bronze, RS type. NRS type where exceptions apply.
7. Disc: Solid wedge; bronze with stainless steel seat ring.
8. Packing: Asbestos free.
9. Operator: Malleable iron handwheel.

2.14 IRON GATE VALVES

- A. Class 250:
 1. Comply with MSS SP-70, Type I.
 2. 2-1/2 NPS to 12 NPS, CWP Rating: 500 psig.
 3. 14 NPS to 24 NPS, CWP Rating: 300 psig.
 4. Body: Cast iron, ASTM A126 Class B with bolted bonnet.
 5. Ends: Flanged.
 6. Trim: Bronze.
 7. Stem: OS&Y, RS type. NRS type where exceptions apply.
 8. Disc: Solid wedge.
 9. Packing and Gasket: Asbestos free, 2-piece packing gland assembly.
 10. Operator: Malleable iron handwheel.

2.15 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 2. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
 3. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.
- B. Verify valve parts to be fully operational in all positions from closed to fully open.
- C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
- D. If valve is determined to be defective, replace with new valve.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Locate valves for easy access. Provide access doors and fire rated access doors as required.
- C. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- D. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.
- E. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, elsewhere as indicated.
- F. Install three-valve bypass around each pressure reducing valve using throttling-type valves.

- G. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- H. Install valves in a position to allow full stem movement.
- I. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- J. Valves with soldered end connections:
 - 1. Use solder with a melting point as follows:
 - a. Below 840 degrees F for gate, globe, and check valves.
 - b. Below 421 degrees F for ball valves.
- K. Install check valves where necessary to maintain direction of flow as follows:
 - 1. Lift Check: Install with stem plumb and vertical.
 - 2. Swing Check: Install horizontal maintaining hinge pin level.
 - 3. Orient plate-type into horizontal or vertical position, between flanges.
- L.
- M. Provide Clamp lock hand lever operators on valves less than 8". Provide hand wheel and closed housing worm gear on valves 8" and larger
- N. Provide chainwheels on operators for valves 4 NPS and larger where located 72 inches or more above finished floor in mechanical rooms, terminating 60 NPS above finished floor.

3.03 FIELD QUALITY CONTROL

- A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leak; replace valves if leak persists.

3.04 ADJUSTING AND CLEANING

- A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.
- B. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

3.05 VALVE SCHEDULE

- A. Bronze Globe Valves, Class 150:

MANUFACTURER	THREADED NRS	THREADED RS	SOLDER RS
Milwaukee	--	590T	1590T
Nibco	--	T-235-Y	S-235-Y

- B. Bronze Globe Valves, Class 200:

MANUFACTURER	THREADED RS
Milwaukee	592A
Nibco	T-256-AP

- C. Bronze Ball Valves – 2 inch and smaller, Class 150:

- 1. Model for chrome plated brass ball indicated. Furnish SS ball if specified in Part 2.

MANUFACTURER	THREADED ENDS	SOLDER ENDS
Apollo	77C-140	77C-240
Hammond	8301A	8311A

Milwaukee	BA-400	BA-450
Nibco	T-585-70	S-585-70
Watts	LFB6080G2	LFB6081G2

D. Bronze Ball Valves, Class 250:

<u>MANUFACTURER</u>	<u>THREADED ENDS</u>
Apollo	70-140-64
Nibco	T-585-70-66-ST

E. Iron Butterfly Valves, 200 psig CWP:

<u>MANUFACTURER</u>	<u>SERIES</u>
Apollo	LD141
Crane Center Line	44
Keystone	222
Nibco	LD-2000
Hammond	6411

F. Iron Butterfly Valves, 250 psig CWP:

<u>MANUFACTURER</u>	<u>SERIES</u>
Keystone	Paraseal
Nibco	LD-3000

G. Bronze Lift Check Valves, Class 150:

<u>MANUFACTURER</u>	<u>HORIZONTAL</u>
Crane	27TF

H. Bronze Swing Check Valves:

<u>MANUFACTURER</u>	<u>CLASS 125 THREADED</u>	<u>CLASS 125 SOLDER</u>	<u>CLASS 150 THREADED</u>	<u>CLASS 200 THREADED</u>
Apollo	163T	163S	164T	169T
Milwaukee	509-T	1509-T	510-T	508
Nibco	T-413-Y	S-413-Y	T-433-Y	T-453-B

I. Iron Flanged End Swing Check Valves:

<u>MANUFACTURER</u>	<u>CLASS 125</u>	<u>CLASS 250</u>
Apollo	910F	920F
Crane	373	39E
Milwaukee	F2974	F2970
Nibco	F-918-B	F-968-B

J. Iron Wafer Plate-Type Check Valves:

<u>MANUFACTURER</u>	<u>CLASS 125</u>	<u>CLASS 250</u>
Apollo	910WB	910WE
Center Line	800	--
Crane	DuoChek II G12HAP	DuoChek G25
Metraflex	CVOSSXXX	CVOSSXXX
Nibco	W-920-W	W-960-W

K. Bronze Gate Valves, Class 125:

<u>MANUFACTURER</u>	<u>THREADED</u>	<u>THREADED</u>	<u>SOLDER</u>	<u>SOLDER</u>
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	NRS	RS	NRS	RS
Apollo	102T	101T	102S	101S
Crane	438	428	--	--
Milwaukee	105	148	115	149
Nibco	T113	T111	S113	S111

L. Bronze Gate Valves, Class 150:

MANUFACTURER	THREADED NRS	THREADED RS	SOLDER NRS	SOLDER RS
Apollo	106T	107T	--	--
Crane	437	431	1324	1334
Milwaukee	1141	1151	--	1169
Nibco	T-136	T-134	S-136	S-134

M. Iron Gate Valves, Class 250:

MANUFACTURER	OS&Y RS	NRS
Apollo	621F	620F
Milwaukee	F2894A	--
Nibco	F-667-0	F-669

END OF SECTION 23 05 23

1.01 **SECTION 230529**

1.02

1.03 **SUPPORTS, ANCHORS AND ISOLATORS**

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Horizontal-piping hangers and supports.
 - 2. Vertical-piping clamps.
 - 3. Hanger-rod attachments.
 - 4. Welded steel brackets.
 - 5. Spring cushions.
 - 6. Saddles and shields.
 - 7. Roof mounted duct, pipe and equipment supports.
 - 8. Equipment spring isolators.
 - 9. Neoprene pad supports.
 - 10. Miscellaneous materials.
- B. Supports specific to individual mechanical and plumbing systems and included in other Divisions and Sections.

1.2 DEFINITIONS

- A. Terminology used in this section is defined in MSS SP-90.

1.3 SUBMITTALS

- A. Product data, including dimensions, materials and installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing Manufacturer's figure number, application and features for each required pipe hanger and support.
 - 1. Application schedule to include pipe or duct system, size, hanger and/or support type with accessories, support spacing and building attachments. Include manufacturer and model number in schedule.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with applicable building codes pertaining to product materials and installation of supports and anchors.
- B. NFPA Compliance: Hangers and supports shall comply with NFPA Standard No. 13 and 14 when used as a component of a fire protection system.

- C. UL and FM Compliance: Hangers, supports, and components shall be listed and labeled by UL and FM where used for fire protection piping systems.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.
1. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.
 2. Pipe supports shall be copper or shall have a nonmetallic coating for electrolytic protection where attachments are in direct contact with un-insulated copper.
- B. Horizontal Piping Hangers and Supports:
1. Adjustable Steel Clevis Hanger: MSS Type 1. Use for all sizes of insulated piping, and all uninsulated piping larger than 3-inch diameter, except for steam and condensate pipe.
 2. Adjustable Roller Hanger: MSS Type 43. Use for all steam piping and all condensate pipe supported from above.
 3. Adjustable Steel Band Hanger: MSS Type 7. Use for un-insulated steel pipe 3-inch diameter and smaller.
 4. Adjustable Copper Band Hanger: MSS Type 9. Use for uninsulated copper piping 3-inch diameter or less.
 5. Pipe Saddle Support: MSS Type 37, including steel pipe base support and cast-iron floor flange with U-bolt pipe restraint.
 6. Adjustable Pipe/Equipment Saddle Support: MSS Type 38, including steel pipe base support and cast-iron floor flange.
 7. Adjustable Pipe Roller and Base: MSS Type 46, suitable for outdoor installation. Use where indicated on the drawings.
 8. Wall Brackets: MSS Type 31, 32 or 33 welded steel securely anchored to wall substrate.
 9. U-Bolts: MSS Type 24.
- C. Vertical Piping Clamps:
1. Riser Clamp: MSS Type 8.
 2. Pipe Clamps with Spring Support: Amber/Booth Type SWP with base plate and mounting bolt holes, adjusting nut, top plate and riser clamp.
 - a. Provide where indicated on the drawings.

D. Hanger Rod Attachments:

1. Steel Turnbuckle: MSS Type 13.

E. Welded Steel Brackets:

1. MSS Type 31, 32 or 33, as required by loading.

F. Spring Cushions:

1. MSS Type-48. Use for top of vertical pipe risers, all refrigerant piping, support of unit heaters, fan coil units, cabinet unit heaters, computer room units, horizontal in-line fans, generator exhaust pipe and mufflers, and elsewhere where specified or shown on the drawings.

G. Saddles and Shields:

1. Protective Shield: MSS Type 40, galvanized, length and gauge as recommended by manufacturer to prevent crushing of insulation or at minimum per Part 3 of this Section.
2. Saddles for Steam Pipe: MSS Type 39A or 39B, steel, welded to pipe, length as recommended by manufacturer and sized to match pipe insulation thickness.

H. Equipment Spring Isolators: Provide, where not provided by equipment manufacturers, housed steel springs with leveling bolts, base pad, and base plate with bolt holes predrilled. Provide number and size required for equipment supported. Provide products from one of the following Manufacturers.

1. Mason Industries
2. Korfund
3. Amber Booth
4. Vibro-Acoustics

I. Inertia Bases: Welded steel channel frame with steel reinforcing bars 8 inches on center welded to frame, minimum 3-1/2-inch depth. Fill with 3000 psi concrete with equipment anchor bolts set in concrete. Provide brackets welded to frame for attachment of spring isolators.

J. Neoprene Pad Supports: Ribbed neoprene, 3/8" thickness, Amber/Booth "Ampad" Type NR or approved equal.

2.2 MISCELLANEOUS MATERIALS

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

2.3 ROOF MOUNTED DUCT, PIPE AND EQUIPMENT SUPPORTS

A. Provide shop fabricated equipment supports for roof mounted ducts, pipes and equipment where indicated on the drawings.

B. Fabricate support using 18-gauge galvanized steel, with wood nailer.

C. Provide shims and base plate, as required to level and to make support compatible with

roofing system.

- D. Construct dimensions required by equipment, pipe or duct supported.
- E. Unistrut model Unipier roof pipe and duct supports.
- F. Dura-Bloc model BD roof pipe and duct supports.
- G. Thycurb Model TEMS-3 or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions under which supports, and anchors are to be installed. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure (beams and joists); comply with MSS SP-69 and SP- 89. Arrange for grouping of parallel runs of horizontal piping supported together on field- fabricated, heavy-duty trapeze where possible. Where piping of various sizes is supported together by trapeze, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
- B. Install additional supports at concentrated loads, as shown on drawings, and including equipment, valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping.
- C. Support from Structural Steel: Liquid filled piping may be supported directly off of the structural framing members as outlined below. Where pipes are supported or hung from steel joists or beams, the supports or hangers shall not be hung from or fastened to the bottom chord of the joists or flange of beam but shall be supported and fastened to the top chord of the joists or flange of beam. Only clamps or fasteners manufactured for this purpose may be used. Where runs of piping are parallel to the joists or beams and are located between joists or beams, pre-fabricated support channels shall be installed to span between the joist top chords or beam flanges for support of hangers. Channel supports shall be attached to joist top chords or beam flanges as described above.
- D. Use of Hanger Tabs: Hanger tabs provided as an integral part of the composite steel floor deck shall be used for support of ceiling loads only. Piping, wiring, ductwork and other mechanical loads shall not be suspended from these hanger tabs.
- E. Field-Fabricated, Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS D-1.1.
- F. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- G. Pipe Slopes: Install hangers and supports to provide pipe slopes where specified or required.

- H. Insulated Piping: Install protective shields MSS Type 40. Shields shall span an arc of 180 degrees and shall have dimensions in inches not less than the following:

<u>NPS</u>	<u>LENGTH</u>	<u>THICKNESS (GAUGE)</u>
1/2 through 3	12	0.048 (18)
4	12	0.060 (16)
5 and 6	18	0.060 (16)
8 through 14	24	0.075 (14)
16 through 24	24	0.105 (12)

1. Insert material shall be at least as long as the protective shield. Provide insert on all piping 1 inch and larger. All piping shall have insert material per Specification Section 230700.
 2. Steam and condensate piping shall have a welded steel saddle when installed on pipe roller supports.
- I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.

3.3 SPACING OF HORIZONTAL PIPE HANGERS:

- A. Except as otherwise specified in individual pipe sections or shown on the drawings, provide pipe hangers spaced no greater than that shown in following table:

PART 2 - STEEL PIPE SUPPORTS

<u>Pipe Size</u>	<u>Max. Span</u>	<u>Min. Rod Size</u>
3/4"	7 ft.	3/8"
1"	7 ft.	3/8"
1-1/4"	7 ft.	3/8"
1-1/2"	9 ft.	3/8"
2"	10 ft.	3/8"
2-1/2"	10 ft.	1/2"
3"	12 ft.	1/2"
4"	14 ft.	5/8"
5"	16 ft.	5/8"
6"	17 ft.	3/4"
8"	19 ft.	7/8"
10"	20 ft.	7/8"
12"	23 ft.	7/8"
14"	25 ft.	1"
16"	27 ft.	1"
18"	28 ft.	1-1/4"
20"	30 ft.	1-1/4"

Copper Pipe Supports

<u>Pipe Size</u>	<u>Max. Span</u>	<u>Min. Rod Size</u>
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1/2"	4 ft.	3/8"
3/4"	5 ft.	3/8"
1"	6 ft.	3/8"
1-1/4"	6 ft.	3/8"
1-1/2"	8 ft.	3/8"
2"	8 ft.	3/8"
2-1/2"	9 ft.	1/2"
3"	10 ft.	1/2"
4"	10 ft.	1/2"

B. Vertical Support:

1. Support vertical piping at each floor or roof.

3.4 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.
- C. Install powder actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
- D. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

3.5 ADJUSTING

- A. Hanger and Support Adjustment: Adjust hangers and supports to distribute loads equally on attachments and to achieve indicated slope of pipe.

END OF SECTION 230529

SECTION 23 05 53 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Stencils.
- E. Pipe markers.
- F. Ceiling tacks.
- G. Engraved plastic-laminate signs.

1.02 SUBMITTALS

- A. Custom Signage: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Valve Tag Schedule: Submit 8-1/2 x 11 inch typewritten valve schedule. Furnish one extra copy for each maintenance manual. Include the following information in the schedule:
 - 1. Valve tag number.
 - 2. Piping system and system abbreviation as shown on tag.
 - 3. Location of valve (room or space).
 - 4. Variations for identification (if any).
 - 5. Function. Specially mark valves which are intended for emergency shut-off and similar special uses in margin of schedule.
 - 6. Valve manufacturer's name and model number.
- C. Product Data: Submit manufacturer's technical product data for each product required.
- D. Manufacturer's Installation Instructions: Indicate special procedures and installation for each product required.

1.03 SPARE PARTS

- A. Furnish minimum of 5 percent extra stock of each mechanical identification material required for each system that uses the identification material.
- B. Furnish not less than 3 additional numbered valve tags for each piping system.
- C. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock along with stenciling paints and applicators.

PART 2 - PRODUCTS AND MATERIALS

2.01 ACCEPTABLE MANUFACTURERS

- A. Advanced Graphic Engraving, LLC.
- B. Brady Corporation.

- C. Brimar Industries, Inc.
- D. Craftmark.
- E. Industrial Safety Supply Co., Inc.
- F. Kolbi Pipe Marker Co.
- G. MIFAB, Inc.
- H. Seton Identification Products, a Tricor Direct Company..

2.02 IDENTIFICATION APPLICATIONS AND REQUIREMENTS

- A. General:
 - 1. Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than a single type is specified for application, selection is the installer's option, but provide single selection for each product category.
 - 2. Lettering: Coordinate names, abbreviations, and other designations used in mechanical identification work with the corresponding designations shown on the drawings, scheduled, and specified. If not otherwise indicated, provide numbering, lettering, and wording as recommended by the manufacturer or as required for proper identification, operation, and maintenance of mechanical systems and equipment.
 - 3. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (e.g., Boiler No. 3, Air Supply No. 1H, etc.).
- B. Air Handling Units: Nameplates, stencils, or engraved plastic laminate signs.
- C. Air Terminal Units: Tags, stencils, or engraved plastic laminate signs.
- D. Automatic Controls: Tags, use the same naming convention coordinated with the building automation system.
- E. Control Panels: Nameplates.
- F. Dampers: Ceiling tacks where located above lay-in ceiling. Do not use ceiling tacks in a gyp ceiling.
- G. Ductwork: Adhesive-backed duct markers. Stencils are only acceptable for concealed ductwork, exterior ductwork, or in mechanical rooms.
- H. Fans: Nameplates, stencils, or engraved plastic laminate signs.
- I. Heat Transfer Equipment: Nameplates, stencils, or engraved plastic laminate signs.
- J. Humidifiers: Nameplates or engraved plastic laminate signs.
- K. Instrumentation: Tags.
- L. Major Control Components including Variable Frequency Drives: Nameplates or engraved plastic laminate signs.
- M. Piping: Pipe Markers.
- N. Pumps: Nameplates or engraved plastic laminate signs.
- O. Relays: Tags.
- P. Small-sized Equipment: Tags.
- Q. Tanks: Nameplates or engraved plastic laminate signs.
- R. Thermostats: Nameplates.

- S. Valves: Tags. Ceiling tacks are acceptable where located above a lay-in ceiling. Do not use ceiling tacks in a gyp ceiling.
- T. Water Treatment Devices: Nameplates or engraved plastic laminate signs.
- U. General Signs: Engraved plastic laminate signs.

2.03 NAMEPLATES

- A. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
 - 1. Name and mark number.
 - 2. Equipment service.
 - 3. Design capacity.
 - 4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.
- B. Size: 2-1/2 inch x 4 inch for control panels and components, 4-1/2 inch x 6 inch for equipment.
- C. Letter Color: White.
- D. Letter Height: 1/4 inch.
- E. Background Color:
 - 1. Cooling equipment: Green.
 - 2. Heating equipment: Yellow.
 - 3. Combination cooling and heating equipment: Yellow/Green.
 - 4. Energy reclamation equipment: Brown.
 - 5. Hazardous equipment: Colors and designs recommended by ASME.
 - 6. Equipment and components that do not meet any of the above criteria: Blue.
- F. Plastic: Conform to ASTM D709.

2.04 TAGS

- A.
- B. Metal Tags: Provide 19-gauge polished brass with stamped letters. Tag size minimum 1-1/2 inch diameter with smooth edges and 5/32 inch hole for fastener. Fill tag engraving with black enamel paint.
- C. Accident Prevention Tags: Pre-printed or partially pre-printed, of plasticized card stock with matte finish suitable for writing, minimum 3-1/4 inch x 5-5/8 inch size, with brass grommet in hole for fastener. Order with appropriate pre-printed wording (e.g., DANGER, CAUTION, DO NOT OPERATE, etc.).
- D. Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks of the size required for proper attachment of tags to valves, manufactured specifically for that purpose.
- E. Valve Tag Chart: Typewritten letter size list in anodized aluminum or finished hardwood frame, covered with SSB-grade sheet glass. Provide frame and mounting screws for removable mounting.
- F. Letter Height:
 - 1. System Abbreviation: Minimum 1/4 inch.
 - 2. Valve Number: Minimum 1/2 inch.

2.05 ADHESIVE-BACKED DUCT MARKERS

- A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- B. Style: Individual label.
- C. Nomenclature: Include air handling unit identification number, duct size, service, and arrows indicating direction of flow.
- D. Specialty Exhaust: Identify the specialty using the system terminology (e.g., Grease, Dishwasher, Dryer, Fume Hood, etc.).
- E. Color: Yellow background with black lettering or blue background with white lettering.
 - 1. Hazardous Exhaust: Use colors and designs recommended by ASME A13.1.

2.06 STENCILS

- A. Stencils: With clean cut symbols and letters of following size, complying with ASME A13.1:
 - 1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
 - 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
 - 3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
 - 4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
 - 5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
 - 6. Ductwork and Equipment: 2-1/2 inch high letters.
 - 7. Access Doors: 3/4 inch high letters.
 - 8. Operational Instructions: 3/4 inch high letters.
 - 9. Provide arrows indicating direction of flow.
- B. Stencil Paint: Oil based, alkyd enamel, either brushing grade or pressurized spray-can form and grade, black color, except for piping. For piping systems use colors conforming to ASME A13.1.

2.07 PIPE MARKERS

- A. Semi-rigid Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- B. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
 - 1. Detection: Provide multi-ply tape consisting of solid aluminum foil core between two layers of plastic ribbon tape.
- C. Nomenclature: Manufacturer's standard pre-printed nomenclature which best describes piping system. Differentiate between supply and return. In the case of a variance, provide nomenclature as selected by the Engineer.
- D. Arrows: Provide pipe markers with integral arrows indicating direction of flow or as a separate unit of plastic.

- E. Color:
 - 1. Conform to ASME A13.1.
 - 2. Heating, Cooling, and Boiler Feedwater: Green with white letters.
 - 3. Toxic and Corrosive Fluids: Orange with black letters.
 - 4. Compressed Air: Blue with white letters.
- F. Letter Height: Minimum 1/2 inch for pipes up to 3 inch, minimum 1 inch for larger pipes.

2.08 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color:
 - 1. HVAC Equipment: Yellow.
 - 2. Fire Dampers and Smoke Dampers: Red.
 - 3. Heating/Cooling Valves: Blue.

2.09 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Engraving stock melamine plastic laminate, engraved with manufacturer's standard letter style, black with white core letter color except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/16 inch thick for units up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger units.
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
- D. Nomenclature: When used to identify equipment, match terminology on schedules, including the following:
 - 1. Name and mark number.
 - 2. Equipment service.
 - 3. Design capacity.
- E. Access Panel Markers: Laminated three-layer plastic, minimum 1/16 inch thick and 1/8 inch hole for fastener, with abbreviations and numbers corresponding to concealed valve.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.02 GENERAL INSTALLATION

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- B. Install products in accordance with manufacturer's instructions.

- C. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- D. Install tags on piping 3/4 inch diameter and smaller.
- E. Install in clear view and align with axis of piping.
- F. Apply stencil painting in accordance with Division 09.
- G. Identify service, flow direction, and pressure.

3.03 PIPING IDENTIFICATION

- A. General: Install identification on the most obviously visible portion of the pipe from the point of access.
- A. Color-coded plastic wrap-around labels are an acceptable alternative to painting on insulated pipe. Plastic labels shall only be applied in accordance with code-limitations for smoke developed and flame spread ratings.
- B. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- C. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe during back-filling/top-soiling of each underground piping system. Where multiple pipes are buried in common trench and do not exceed overall width of 16 inches, install single pipe marker. For tile fields and similar artificial field installations, mark only edge pipe lines of field.
- D. Pipes less than 6 inches diameter (including insulation): Provide full-band pipe markers with 360 degree coverage.
- E. Pipes 6 inches diameter and larger (including insulation): Provide either full-band or strip-type pipe markers
- F. Application: Provide piping system identification for the following systems:
 - 1. Fuel oil piping (indicate supply and return systems, accordingly).
 - 2. Chilled water piping (indicate supply and return systems, accordingly).
 - 3. Heating water piping (indicate supply and return systems, accordingly).
 - 4. Condenser water piping (indicate supply and return systems, accordingly).
 - 5. Steam piping (indicate PSI of systems, accordingly).
 - 6. Steam condensate piping (indicate high, medium and low pressure systems, accordingly).
 - 7. Refrigerant piping (indicate liquid and suction systems, accordingly).
- G. Location: Install piping identification where piping is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc.) and exterior non-concealed locations as follows:
 - 1. Within 5 feet of each valve, tee, and control device.
 - 2. Within 5 feet of each branch, excluding branches less than 20 feet in length to fixtures or terminal heating and cooling units.
 - 3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.
 - 4. At access doors, manholes and similar access points which permit view of concealed piping.
 - 5. Within 5 feet of equipment outlets and other points of origination and termination.

6. Spaced intermediately at a maximum spacing of 50 feet along each riser and run. Reduce spacing to 25 feet in congested areas where there are more than two piping systems or pieces of equipment.
- H. Mechanical piping in mechanical rooms, boiler rooms, and powerhouses shall be color codes to indicate service. See HCA Piping Color Table below for recommended color scheme. For work in existing facilities, contractor is to match existing color scheme.

HCA Piping Color Table	
Piping	Color Description
Low Temp Supply	Dark Purple
Low Temp Return	Light Purple
Chilled Water Supply	Dark Blue
Chilled Water Return	Light Blue
Condenser Water Supply	Bright Green
Condenser Water Return	Dark Green
Hot Water Supply	Bright Red
Hot Water Return	Dark Red
Condensate	Dark Orange
Steam	Bright Orange
Natural Gas	Bright Yellow
Fuel Oil	Brown
Domestic Water	Blue

1.

3.04 VALVE IDENTIFICATION

- A. General: Valve tags are required for all emergency shutoff valves and all manual valves 1" and larger. Emergency shutoff valves shall include all valves 2" and larger for the following services: domestic hot and cold water, chilled water, heating hot water, steam and steam condensate and natural gas. Mark ceiling grid with colored marker indicating valve locations above the ceiling. Mount valve tag chart and schedule frame in mechanical room, or where indicated on plans. If not indicated, mount where directed by Engineer. Where more than one mechanical room is included on the project, mount framed copies of valve tag chart and schedule in each mechanical room.

3.05 DUCTWORK IDENTIFICATION

- A. Install identification on the most obviously visible portion of the duct from the point of access.
- B. Location: Install ductwork identification where ductwork is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc), and exterior non-concealed locations as follows:
 1. Within 5 feet of each control damper or balancing damper, excluding balancing dampers installed in duct take-offs to individual grilles, registers, or diffusers that are less than 25 feet in lengths and installed in the same space as the air device.
 2. Within 5 feet of each branch duct, excluding branch ducts that are less than 25 feet in length and located in the same space as the main duct.
 3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.

4. Spaced intermittently at a maximum spacing of 50 feet along each duct run. Reduce spacing to 25 feet in congested areas when there are more than two types of duct systems or pieces of equipment.
5. Within 5 feet of equipment outlets and other points of origin or termination.
6. Install marker on the most obviously visible portion of the duct from point of access.

3.06 ACCESS DOOR IDENTIFICATION

- A. Provide identification on each access door, indicating purpose of access, maintenance and operating instructions, and appropriate safety and procedural information.
- B. Where access doors are concealed above a removeable ceiling system or similar concealment, tags may be used in lieu of specified identification.

3.07 CEILING TACK INSTALLATION

- A. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

3.08 EQUIPMENT IDENTIFICATION

- A. Install nameplates and engraved plastic laminate signs for identification of equipment. Provide additional signs and lettering as follows:
 1. To distinguish between multiple units in close proximity.
 2. To inform operator of operational requirements.
 3. To indicate safety and emergency precautions.
 4. To warn of hazards and improper operations.
- B. Adjust lettering size based on viewing distance from normal location of identification:
 1. Less than 2 feet: Minimum 1/4 inch.
 2. Up to 6 feet: Minimum 1/2 inch.
 3. Greater than 6 feet: Proportionally increase letter size based on recommendations above.
 4. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
 5. Stencils may be used in lieu of nameplates when lettering greater than 1 inch is needed for proper identification because of distance from normal location of required identification.
- C. CAV/VAV terminal units concealed above lay-in ceilings shall be marked by a marker clipped to the grid.

END OF SECTION 23 05 53

SECTION 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. General testing, adjustment, and balancing requirements.
- B. Pre-testing, adjustment, and balancing of existing air systems.
- C. Pre-testing, adjustment, and balancing of existing hydronic systems.
- D. Testing, adjustment, and balancing of air systems.
- E. Testing, adjustment, and balancing of hydronic systems.
- F. Testing, adjustment, and balancing of domestic water systems.
- G. Testing, adjustment, and balancing of steam systems.
- H. Sound and vibration measurement of equipment operating conditions.
- I. This section excludes:
 - 1. Testing boilers and pressure vessels for compliance with safety codes;
 - 2. Specifications for materials for patching mechanical systems;
 - 3. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
 - 4. Requirements and procedures for piping and ductwork systems leakage tests.

1.02 DEFINITIONS

- A. TAB: Testing, adjusting, and balancing.
- B. Test: To determine quantitative performance of equipment.
- C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).
- D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.
- E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.
- F. Report forms: Data sheets arranged for collecting test data in logical order for submission and review. Data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.
- G. Terminal: The point where the controlled fluid enters or leaves the distribution system. Examples include inlets and outlets on water terminals, inlets and outlets from air terminal units, and inlets and outlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
- H. Main: Duct or pipe containing the major or entire fluid flow of the system.
- I. Submain: Duct or pipe containing part of the system capacity and serving two or more branch mains.
- J. Branch main: Duct or pipe serving two or more terminals.
- K. Branch: Duct or pipe serving a single terminal.

1.03 SUBMITTALS

- A. Qualifications:
 - 1. Submit qualifications of TAB agency.
 - 2. Submit qualifications of TAB supervisor.
- B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
- C. Sample Forms: Submit sample forms if they are other than the standard forms available from the certification association followed for the project.
- D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- E. Progress Reports.
- F. Certified TAB Reports:
 - 1. General:
 - a. Submit within two weeks after completion of testing, adjusting, and balancing.
 - b. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - c. Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 2. Draft Report: Submit draft copies of report for review prior to final acceptance of Project. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
 - 3. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. The final report shall be certified proof of the following:
 - a. The systems have been tested, adjusted, and balanced in accordance with the referenced standards.
 - b. The report reflects an accurate representation of how the systems have been installed.
 - c. The report reflects a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures.
 - d. The report is an accurate record of all final quantities measured to establish normal operating values of the systems.
 - 4. Report Format: Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, and cover identification at front and side. Include set of reduced size drawings indicating air outlets, equipment, and thermostat locations identified to correspond with report forms. Divide the report into the following divisions:
 - a. General Information and Summary
 - 1) Include project name, location, altitude, and date.
 - 2) Identify TAB agency, contractor, owner, architect, and engineer.
 - 3) Include addresses, contact names, and telephone numbers.

- 4) Include certification sheet containing the seal, name, address, telephone number, and signature of the certified TAB Supervisor.
- 5) Include actual instrument list, with manufacturer name, serial number, and date of calibration.
- b. Air Systems
- c. Hydronic Systems
- d. Temperature Control Systems
- e. Special Systems
- f. Sound and Vibration Systems
5. Report Forms: Standard forms prepared by the TAB certification standard being followed for each respective item and system to be tested, adjusted, and balanced. If not specified, follow ASHRAE 111.
6. Units of Measure: Report data in I-P (inch-pound) units only.
- G. Project Record Documents: Provide drawings that record actual locations of flow measuring stations and balancing devices.

1.04 QUALITY ASSURANCE

- A. Comply with ASHRAE Standard 111, Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
- B. Comply with ASHRAE Handbook, HVAC Applications Volume, Chapter "Testing, Adjusting, and Balancing", most current edition.
- C. TAB Agency Qualifications:
 1. Act as the single source of responsibility for TAB of the HVAC systems.
 2. Staff the project at all times by qualified personnel.
 3. The TAB Contractor shall be a sub-contractor to the General Contractor and be financially independent from all other sub-contractors associated with the project.
 4. The Mechanical Contractor shall coordinate his work with the TAB Contractor and correct any system deficiency identified in the General Contractor's and TAB Contractor's inspection.
 5. Specify that TAB Contractor shall be an active participant in the commissioning process as specified in Section 01 91 13.
 6. Have a minimum of 5 years documented experience on projects with TAB requirements similar to those required for the project.
 7. Certified by one of the following Certification Associations:
 - a. NEBB: National Environmental Balancing Bureau, Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
- D. TAB Supervisor and Technician Qualifications:
 1. Certified by the same organization as TAB agency.
 2. TAB Supervisor shall be a professional engineer licensed in the state in which the project is located.

PART 2 - PRODUCTS AND MATERIALS – NOT USED

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Begin work after systems to be tested, adjusted, or balanced are fully operational, duct systems are sealed, piping systems have been tested for leaks, and equipment is operational. Complete work prior to Substantial Completion of the project.
- B. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems.
- C. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 5 deg. F wet bulb temperature of maximum summer design condition, and within 10 deg. F dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.
- D. Coordinate with Division 22 drawings for testing, adjusting, and balancing scope of work.
- E. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- F. Submit progress reports at least once a week to the General Contractor to communicate status of work so that the TAB work is completed in a timely manner.
- G. Notice of Tests: Provide seven days advance notice for each test. Include scheduled test dates and times.
- H. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- I. All required instrumentation shall be calibrated to tolerances specified in the referenced standards within a period of six months prior to starting the project.

3.02 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Motors and bearings are lubricated.
 - 5. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 6. Duct systems are clean of debris.
 - 7. Fans are rotating correctly and belts have tension.
 - 8. Fire, smoke, fire/smoke, and volume dampers are in place and open.
 - 9. Air coil fins are cleaned and combed.
 - 10. Volume dampers are installed at locations needed for balancing the air systems.

11. Access doors are closed and duct end caps are in place.
 12. Air outlets are installed and connected.
 13. Visually inspect duct systems to ensure they are sealed and leakage is minimized.
 14. Hydronic systems are flushed, filled, and vented.
 15. Hydronic systems are tested for leaks.
 16. Test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves are properly installed and that their location is accessible.
 17. Pumps are rotating correctly.
 18. Proper strainer baskets are clean and in place.
 19. Service and balance valves are open.
 20. Expansion tanks are not air bound and have appropriate charge.
 21. Air vents are operating freely.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

- A. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a coordination meeting with all installers whose work will be tested, adjusted, or balanced.
- B. Furnish all instruments required for testing, adjusting, and balancing operations.
1. Verify all instruments have been calibrated.
 2. Furnish instruments as recommended by the manufacturer for the TAB application.
 3. Furnish instruments that are best suited to the function being measured.
 4. Furnish instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.
- C. Furnish additional balancing devices as required for TAB to the appropriate contractor for installation.
- D. Obtain copies of approved shop drawings of air handling equipment, terminal outlets, and temperature control diagrams.
- E. Obtain manufacturer's fan and terminal device outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.
- F. Determine best locations in main and branch ductwork for most accurate duct traverses.
- G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

3.04 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Balance main ducts and equipment to within plus or minus 5 percent of design airflow.
- B. Air Outlets and Inlets: Balance individual Supply terminal devices and branch lines to ± 10 percent and main ducts and air handling equipment to ± 5 percent of specified airflow. Return

branch and mains shall be balanced ± 5 percent of specified airflow, exhaust shall be within-10% of design airflow.

C. Differential Space Pressure:

1. Positive Zones: Balance to within 0 to plus 10 percent supply air and 0 to minus 10 percent for exhaust and return air.
2. Negative Zones: Balance to within 0 to minus 10 percent supply air and 0 to plus 10 percent exhaust and return air.

D. Hydronic Systems: Balance to within plus or minus 5 percent of design flow.

3.05 RECORDING AND ADJUSTING

- A. Record data regarding design conditions from contract documents and installed conditions from shop drawings including equipment identification number, model number, location, area served, manufacturer, model number, serial number, motor nameplate horsepower and rpm, fan rpm, capacity and electrical voltage, amps and phases.
- B. The TAB contractor shall compare the sum of the CAV/VAV box diffuser readings with the flow indicated by the box's controller prior to calibrating the box's controller. If the two readings agree within $\pm 5\%$, the factory calibration factors shall not be changed. If the readings are not within $\pm 5\%$, a documented trouble shooting procedure consisting of checking and resolving the following shall be conducted prior to calibrating the controller to verify: (Refer to Tab 3 - Functional Performance Test Procedures)
 1. Box size is per the approved submittal,
 2. Manufacturer's gain/flow factor has been correctly entered into the controller,
 3. Low pressure duct/connections are tight,
 4. Velocity pressure connections at the box inlet and controller are tight and undamaged,
 5. Static pressure at the box's inlet exceeds the minimum required, and
 6. Box flow measuring device is undamaged.
- C. This procedure and results for carrying out steps A-F above are to be retained by the Mechanical Contractor for delivery to the Owner/Design Engineer on request.
- D. TAB contractor shall compile an Excel spreadsheet for all terminal boxes, listing each box by its unique identification number, the inlet flow area established by the box manufacturer, the manufacturer's gain factor for the box, final TAB calibrated gain factor for the box if field calibrated, and the ratio of the calibrated gain factor to the manufacturer's gain factor.
- E. Require the TAB contractor to measure and include in the report the AHU supply and return fans' flow, rpm, hp, and sensed duct static pressure at the dirty differential pressure drop across both the pre-filter and final filter.
- F. The test and balance specification shall require contractor to measure system performance with the pressure drop across filters at the value specified for dirty filters.
- G. TAB shall show in their report all the individual velocity measurements from duct or AHU traverses in grid format.
- H. The TAB report shall include a static profile of each AHU with the supply fan controlling to the minimum sensed duct static pressure necessary for the system terminal units to achieve maximum cooling design flow simultaneously. This static pressure shall be documented in the report and shall become the duct static pressure set point.
- I. The TAB report shall record the VFD speed for all supply and return fan measurements included in the report.

- J. Where AHUs share a common outside air duct, relief duct, or louver, specify that the TAB contractor test those AHUs simultaneously in the 100% economizer mode with all boxes at 100% cooling to verify the supply duct static set point and the design supply/return air volume differential are maintained.
- K. The TAB contractor shall verify building and space pressure relationships in all modes of operation.
- L.
- M. For all systems measure and record the ambient conditions at the time of testing and balancing. Include the following:
 - 1. Dry bulb temperature.
 - 2. Relative humidity.
 - 3. Cloud cover.
 - 4. Wind speed.
 - 5. Time.
- N. Field Logs: Maintain written logs including:
 - 1. Running log of events and issues.
 - 2. Discrepancies, deficient or uncompleted work by others.
 - 3. Contract interpretation requests.
 - 4. Lists of completed tests.
- O. Ensure recorded data represents actual measured or observed conditions.
- P. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- Q. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- R. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- S. Cut insulation around ductwork and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
- T. Patch and seal insulation, vapor barrier, ductwork, and housings, using materials identical to those removed.
- U. Seal ducts and piping and test and repair leaks.
- V. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- W. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- X. Check and adjust systems approximately six months after final acceptance and submit report.
- Y. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive values are obtained.
- Z. Take all readings at eye level of the indicated value to prevent parallax.
- AA. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.

BB. Take measurements in the system where best suited for the task.

CC. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.06 PRE-TESTING, ADJUSTMENT, AND BALANCING OF EXISTING AIR SYSTEMS

A. Perform preconstruction inspection and testing of existing systems as noted on the plans. Submit test report to engineer for approval. Construction on or demolition of the pre-tested systems shall not proceed until the engineer has reviewed and approved the preconstruction test report.

B. TAB Contractor:

1. Measure and record the operating speed, airflow, and total and external static pressure of each fan system. Provide individual pressure drop readings across all coils, filter banks, dampers and other internal fan system components
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the condition of filters.
4. Check the condition of coils.
5. Check the operation of the drain pan and condensate-drain trap.
6. Check bearings and other lubricated parts for proper lubrication.
7. For variable air volume systems: Open automatic air dampers to full design position to simulate a design day. Measure and record the operating speed and airflow of each fan system for full load conditions.
8. Report on the results of the measurements taken and any deficiencies.

C. Mechanical Contractor:

1. Check the refrigerant charge.
2. Report on the operating condition of the equipment and any deficiencies.

3.07 PRE-TESTING, ADJUSTMENT, AND BALANCING OF EXISTING HYDRONIC SYSTEMS

A. Perform preconstruction inspection and testing of existing systems as noted on the plans. Submit test report to engineer for approval. Construction on or demolition of the pre-tested systems shall not proceed until the engineer has reviewed and approved the preconstruction test report.

B. TAB Contractor:

1. Open automatic control valves to full design position to simulate a design day. Close coil bypass valves.
2. Examine HVAC system and equipment installations to verify that existing balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices and balancing valves and fittings are properly installed. Verify that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
3. Remove, clean, and reinsert all strainers.
4. Examine hydronic systems and determine if water has been treated and cleaned.
5. Check pump rotation.
6. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.

7. Check air vents at high points of systems and determine if all are operating freely (automatic type) or to bleed air completely (manual type).
8. Set temperature controls so all coils are calling for full flow.
9. Check operation of automatic bypass valves.
10. Measure and record the operating speed, hydronic flow and pressure drop of each pump and hydronic coil.
11. Measure and record the hydronic flow and pressure drop of each piece of HVAC equipment.
12. Measure motor voltage and amperage. Compare the values to motor nameplate information.

C. Mechanical Contractor:

1. Install additional instrumentation and test ports as requested by the testing, adjusting, and balancing contractor to obtain the necessary measurements of the existing system.

3.08 AIR SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

- A. Check filters for cleanliness.
- B. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
- C. Verify volume dampers are installed at locations needed for balancing the air systems.
- D. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.
- E. Determine best locations in main and branch ductwork for most accurate duct traverses.
- F. Place outlet dampers in the full open position.
- G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.
- H. Lubricate all motors and bearings.
- I. Check fan belt tension.
- J. Check fan rotation.
- K. Energize fan motors and adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude. Replace fan and motor pulleys as required to achieve design conditions.
- L. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- M. Measure air quantities at air inlets and outlets.
- N. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- O. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Affect volume control by duct internal devices such as dampers and splitters.
- P. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- Q. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

- R. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- S. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- T. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- U. Where modulating dampers are provided, take measurements and balance at design conditions. Balance variable volume systems at design air flow rate and at minimum air flow rate.
- V. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship to maintain building pressure setpoint.
- W. Multi-Zone units with Mixing Dampers: Check for motorized damper leakage. Adjust air quantities with mixing dampers set first at design cooling, then at design heating.
- X. For variable air volume boxes, set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.
- Y. On fan powered VAV boxes, adjust air flow switches for proper operation.
- Z. Procedure for establishing minimum and absolute minimum outdoor air damper position on air handling units:
 - 1. Open the minimum outdoor air damper and return air damper fully. Close the economizer air damper.
 - 2. Operate supply fan at design speed and measure the outdoor airflow.
 - 3. If the outdoor airflow is above the scheduled minimum ventilation airflow, adjust the damper linkage on the minimum outdoor air damper so that outdoor airflow equals the scheduled minimum ventilation airflow with damper fully stroked.
 - 4. If outdoor airflow is below the scheduled minimum ventilation airflow, adjust the damper linkage on the return air damper so that outdoor airflow equals the schedule minimum ventilation airflow with the damper fully stroked.
 - 5. Convey the measured setpoint and/or damper position to the BAS installer and note on air balance report.
 - 6. Repeat this procedure to determine damper position for absolute minimum ventilation.

3.09 HYDRONIC SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

- A. Open valves to full open position. Close coil bypass valves.
- B. Remove and clean all strainers.
- C. Check pump rotation.
- D. Clean and set automatic fill valves for required system pressure.
- E. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
- F. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
- G. Set temperature controls so all coils are calling for full flow.
- H. Check operation of automatic bypass valves.
- I. Check and set operating temperatures of chillers to design requirements.

- J. Lubricate all motors and bearings.
- K. Adjust water systems to provide required or design quantities.
- L. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on correlated flow from temperature and pressure gauges across the heat transfer elements in the system.
- M. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- N. Affect system balance with automatic control valves fully open to heat transfer elements.
- O. Affect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- P. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.
- Q. Balance cooling tower water distribution systems to ensure even water flow to each tower cell.
- R. Test cooling tower systems for capacity, recording pump flow and head, fan airflow, ambient air wet and dry bulb temperatures at tower inlet and outlet and tower inlet and outlet water temperatures.
- S. Record the necessary information for optimizing pump operation as defined on the controls drawings. Give this information to the controls contractor for building automation system programming.

3.10 DOMESTIC WATER SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

- A. Before balancing the system perform these steps:
 - 1. Open valves to full open position.
 - 2. Examine plumbing system and equipment installations to verify that indicated balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices and balancing valves and fittings are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
 - 3. Remove and clean all strainers.
 - 4. Check pump rotation.
 - 5. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
 - 6. Lubricate all motors and bearings.

3.11 STEAM SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

- A. Measure and record upstream and downstream pressure of each piece of equipment.
- B. Measure and record upstream and downstream steam pressure of pressure reducing valves.
- C. Check settings and operation of automatic temperature control valves, self-contained control valves, and pressure reducing valves. Record final settings.
- D. Check settings and operation of each safety valve. Record settings.
- E. Verify operation of each steam trap.

3.12 TESTING FOR SOUND AND VIBRATION

- A. Test and adjust mechanical systems for sound and vibration in accordance with the detailed instructions of the referenced standards:
 - 1. ASHRAE: ASHRAE Handbook, HVAC Applications Volume, Chapter "Sound and Vibration Control", most current edition.
 - 2. NEBB: "Procedural Standards for the Measurement and Assessment of Sound and Vibration."
- B. The TAB Contractor shall measure the HVAC background noise level in all the spaces specified in Division 23: Mechanical, Section I: Mechanical General, 1.01F. The sound level shall be measured at the patient head location in patient in patient sleeping and therapy rooms. In all other rooms the sound level is to be measured at the approximate center of the room 48" above floor level. The TAB report shall document the measure NC level for each space. The TAB report shall also include an NC curve for any space that exceeds the specified NC limit.
- C. Other than sound data, failure of an item includes a deviation of more than 10 percent from setpoint. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.
 - 1. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
- D. Prepare and submit report of recommendations for correcting any sound or vibration levels that are outside of manufacturer's tolerances, ASHRAE standards and/or values specified in the contract documents.

END OF SECTION 23 05 93

SECTION 23 07 00 HVAC INSULATION

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. Extent of Mechanical insulation required by this Section is indicated on drawings and schedules, and by requirements of this Section.
- B. Types of Mechanical insulation specified in this Section include the following:
 - 1. Piping Systems Insulation:
 - a. Fiberglass
 - b. Cellular Glass
 - c. Flexible Elastomeric
 - d. Phenolic
 - 2. Ductwork System Insulation:
 - a. Fiberglass
 - 3. Equipment Insulation:
 - a. Fiberglass
 - b. Cellular Glass
 - c. Flexible Elastomeric
- C. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 23 Section "Hangers & Supports for HVAC Piping & Equipment," for insulation shields and pipe saddles for protecting insulation vapor barrier and materials and methods for piping installations.
 - 2. Division 23 Section "Underground Hydronic and Steam Piping," for insulation of piping installed below grade.

1.02 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E 84 (NFPA 255) method.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.
- B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.
- C. Samples: Submit manufacturer's sample of each piping insulation type required, and of each duct and equipment insulation type required. Affix label to sample completely describing product.

PART 2 - PRODUCTS AND MATERIALS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
1. Aeroflex USA, Inc.
 2. Armacell LLC.
 3. CertainTeed Corp.
 4. Johns Manville
 5. Knauf Insulation
 6. K-Flex USA
 7. Owens Corning
 8. Pittsburgh Corning Corp.
 9. Resolco

2.02 PIPING INSULATION MATERIALS

- A. Fiberglass Piping Insulation: ASTM C547, Type I or II, Grade A.
- B. Cellular Glass Piping Insulation: ASTM C552, Type II, Class 2.
- C.
- D. Flexible Elastomeric Piping Insulation: ASTM C534, Type I.
- E. Phenolic Piping Insulation: ASTM C1126 Type III
- F. Jackets for Piping Insulation: ASTM C1136, Type I.
1. PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, Johns Manville Zeston 2000 PVC or approved equivalent. Factory supplied, pre-cut insulation blanket inserts for use with PVC fitting covers are acceptable.
 2. Use all service jacket (ASJ) in equipment rooms. Foam glass concealed above ceilings and within shafts does not need to be covered. Do not use factory pre-applied ASJ on foam glass. The pre-applied jacket prevents application of mastic on the longitudinal and circumferential joints.
 3. For hot water, steam and steam condensate piping shall be insulated with molded fiberglass pipe insulation having ASJ finish
- G. Jackets for Pipe Insulation Exposed to Weather (ONLY FOAM GLASS MAY BE USED EXTERIOR TO BUILDING): Approved by the jacket manufacturer for use with the specific insulation material that it covers.
1. Rigid aluminum shell and fitting covers conforming to ASTM C1729 with weather-proof construction. Shell shall have the following minimum thickness based on the outer insulation diameter:

	Outer Insulation Diameter (in)	Minimum Aluminum Jacket Thickness, (in)	
		Non-Rigid Insulation	Rigid Insulation
Finish			
	≤ 8	0.016	0.016
Stucco			
	< 12	0.020	0.016
Stucco			

	≤ 24	0.024	0.016
Stucco	≤ 36	0.032	0.020
See Note 1	> 36	0.040	0.024
See Note 1			

Note 1: Use corrugated finish for non-rigid insulation. Use stucco finish for rigid insulation.

a. Banding:

- 1) For piping less than or equal to 8 inches, provide 0.020 inch thick, 3/4 inch wide aluminum bands.
- 2) For piping larger than 8 inches, provide 0.020 inch thick, 3/4 inch wide stainless steel bands.

H. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

I. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

1. Vapor Barrier Coating: Comply with MIL-PRF-19565C, Type II.

- a. Water-Based Mastic: Permeance shall be 0.013 perms or less at 43 mils dry per ASTM E 96 Procedure B. Provide Foster 30-80, Childers CP-38 or equal vapor barrier mastic.
- b. Solvent-Based Mastic: Permeance shall be 0.05 perms or less at 35 mils dry per ASTM F 1249.

2. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2 or equal.

3. Weather Barrier Breather Mastic: Permeance shall be 1.0 perms or less at 62 mils dry per ASTM E96, Procedure B. Provide Foster 46-50, Childers CP-10/11 or equal.

J. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.

K. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

L. High Density Insulation:

1. Calcium Silicate conforming to ASTM C533 and C795.
2. Flexible elastomeric piping insulation conforming to ASTM C534, Type 1.

2.03 DUCTWORK INSULATION MATERIALS

A. Rigid Fiberglass Ductwork Insulation: UL/ULC Classified, meeting ASTM C612, Types IA or IB, with density of 3.0 pounds per cubic foot.

B. Flexible Fiberglass Ductwork Insulation: UL/ULC Classified, meeting ASTM C553, Type II, with density of 1.5 pounds per cubic foot.

C. Jackets for Ductwork Insulation: ASTM C1136, Type I or Type II for ductwork. Protective jackets for ductwork shall be ASTM C921 Type I made of sheet aluminum in accordance with ASTM B 209, 3003 alloy, H-14 temper, minimum 0.032 inch thick with a moisture barrier lining except where the protective jacket is applied over a Type I vapor barrier jacket and with stainless steel draw bands.

- D. Ductwork Insulation Accessories: Provide staples, bands, wires, pins with insulation retaining washers, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.
- E. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.
 - 1. Vapor Barrier Coating: Comply with MIL-PRF-19565C, Type II.
 - a. Water-Based Mastic: Permeance shall be 0.013 perms or less at 43 mils dry per ASTM E 96. Provide Fosters 30-80, Childers CP-38 or equal.
 - b. Solvent-Based Mastic: Permeance shall be 0.05 perms or less at 35 mils dry per ASTM F 1249.
 - 2. Fiberglass Adhesive: Comply with ASTM C916, Type 2 or MIL-A-3316C, Class 2, Grade A. Provide Foster 85-60, Childers CP-127 or equal water based adhesive.
- F. Jackets for Duct Insulation Exposed to Weather: Jackets installed over exterior duct insulation shall be approved by the jacket manufacturer for use with the specific insulation material that it covers. Jackets utilized to cover exterior duct insulation shall include one of the following options:
 - 1. Encase fiberglass insulation with rigid aluminum shell with weather-proof construction. Shell shall be minimum 0.032 inch stucco embossed aluminum with three aluminum attachment bands per section and with aluminum fitting covers.

2.04 EQUIPMENT INSULATION MATERIALS

- A. Rigid Fiberglass Equipment Insulation: ASTM C612, Class 2.
- B. Flexible Fiberglass Equipment Insulation: ASTM C553, Types IA and IB
- C. Cellular Glass Equipment Insulation: ASTM C552, Type I.
- D. Flexible Elastomeric Equipment Insulation: ASTM C534, TYPE II.
- E. Jacketing Material for Equipment Insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or metal jacket at Installer's option, except as otherwise indicated.
- F. Equipment Insulation Compounds: Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.
 - 1. Vapor Barrier Coating: Comply with MIL-PRF-19565C, Type II.. Permeance shall be 0.013 perms or less at 43 mils dry per ASTM E 96 or 0.08 perms at 37 mils dry per ASTM F 1249. Provide Foster 30-80, Childers CP-38 or equal.
 - 2. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36. Childers CP-50AHV2 or equal.
 - 3. Fiberglass Adhesive: Comply with ASTM C916, Type II.
- G. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.01 PIPING SYSTEM INSULATION

- A. General: Reference Insulation Schedules at the end of this specification for minimum insulation conductivity and thickness requirements.
- B. Insulation Omitted: Omit insulation on the following:
 - 1. Hot piping within radiation enclosures or unit cabinets;
 - 2. Cold piping within unit cabinets provided piping is located over drain pan;
 - 3. Heating piping between coil and shutoff valves provided piping is located within heated space and not more than three feet from coil;
 - 4. Condensate piping between steam trap and union; and
 - 5. Flexible connections and expansion joints in pipes with fluids above ambient temperatures.
- C. Exterior Piping: Insulate all exterior HVAC piping with cellular glass of thickness noted.
- D. Sub-Zero Piping (Below 0 degrees F (-18 degrees C)):
 - 1. Application Requirements: Insulate the following sub-zero HVAC piping systems:
 - a. Low temperature refrigerant piping.
 - 2. Insulate each piping system specified above with one of the following types of insulation:
 - a. Cellular Glass
 - b. Flexible Elastomeric
 - c. Phenolic
- E. Sub-Freezing Piping (0 to 39 degrees F (-18 to 4 degrees C)):
 - 1. Application Requirements: Insulate the following sub-freezing HVAC piping systems:
 - a. Refrigerant suction lines between evaporators and compressors.
 - b. Refrigerant liquid lines between the expansion valve and the evaporator coil.
 - c. Brine refrigerant piping.
 - 2. Insulate each piping system specified above with one of the following types of insulation:
 - a. Cellular Glass
 - b. Flexible Elastomeric: Insulation shall be seamless except where piping joints need to be made. Seams at piping joints shall be sealed and taped.
 - c. Phenolic
- F. Cold Piping (40 degrees F (4.4 degrees C) to ambient):
 - 1. Application Requirements: Insulate the following cold HVAC piping systems:
 - a. HVAC chilled water supply and return piping.
 - b. HVAC make-up water piping.
 - c. Air conditioner condensate drain piping.
 - d. Condenser water supply and return piping when used for free cooling.
 - 2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:

- a. Cellular Glass
 - b. Flexible Elastomeric
 - c. Phenolic
- G. Warm Temperature Piping (100 degrees to 140 degrees F (38 to 94 degrees C)):
- 1. Application Requirements: Insulate the following warm HVAC piping systems:
 - a. HVAC hot water supply and return piping.
 - b. Refrigerant liquid lines between the condensing unit and evaporator coil.
 - 2. Insulate each piping system specified above with one of the following types of insulation.
 - a. Fiberglass
 - b. Phenolic
- H. Hot Non-Steam Piping (141 to 200 degrees F (61 to 94 degrees C)):
- 1. Application Requirements: Insulate the following hot HVAC piping systems.
 - a. HVAC hot water supply and return piping.
 - b. Heated fuel piping.
 - c. Hot gas refrigerant piping.
 - 2. Insulate each piping system specified above with one of the following types of insulation:
 - a. Fiberglass
 - b. Cellular Glass
 - c. Phenolic
- I. Hot Steam Piping (up to 250 degrees F (121 degrees C)):
- 1. Application Requirements: Insulate the following hot low pressure HVAC piping systems (steam piping up to 15 psi).
 - a. Steam and condensate piping
 - 2. Insulate each piping system specified above with one of the following types of insulation:
 - a. Fiberglass
 - b. Cellular Glass
 - c. Phenolic
- J. Hot Water and Steam Piping (250 to 350 degrees F (122 to 177 degrees C)):
- 1. Application Requirements: Insulate the following hot HVAC piping (steam piping from 16 to 110 psi, water piping 251 to 350 degrees F (122 to 177 degrees C)):
 - a. HVAC hot water supply and return piping.
 - b. Steam and condensate piping.
 - 2. Insulate each piping system specified above with one of the following types of insulation:
 - a. Fiberglass

b. Phenolic

c. Cellular Glass

3.02 DUCTWORK SYSTEM INSULATION

- A. Insulation Omitted: Do not insulate fibrous glass ductwork, or lined ductwork. Refer to Section "Metal Ductwork" for requirements for duct liner material.
- B. Application Requirements:
 - 1. Insulate the following ductwork:
 - a. Outdoor air intake ductwork and plenums between air entrance and fan inlet or HVAC unit inlet.
 - b. HVAC supply ductwork between fan discharge, or HVAC unit discharge, and room terminal outlet.
 - 1) Insulate neck and bells of supply diffusers.
 - c. HVAC return ductwork between room terminal inlet and return fan inlet, or HVAC unit inlet. Omit insulation on return ductwork located in return air ceiling plenums except insulate all return air ductwork within 10 feet of exterior roof or wall penetrations.
 - d. HVAC plenums and unit housings not pre-insulated at factory or lined.
 - e. Exhaust and relief air ductwork and plenums within 10 feet of exterior discharge outlets.
 - 2. Insulate each ductwork system specified above with one of the following types and thickness of insulation:
 - a. Rigid Fiberglass: 2" thick, minimum R-8.0. Use 2" thick, minimum R-8 in machine, fan and equipment rooms.
 - b. Flexible Fiberglass: 3" thick, minimum R-8.0 installed R-value at maximum 25% compression, application limited to concealed locations.

3.03 EQUIPMENT INSULATION

- A. Cold Equipment (Below Ambient Temperature):
 - 1. Application Requirements: Insulate the following cold equipment unless pre-insulated at factory:
 - a. Refrigeration equipment, including chillers, tanks and pumps.
 - b. Drip pans under chilled equipment.
 - c. Chilled water storage tanks.
 - d. Chilled water expansion tanks, air separators and piping accessories.
 - e. Chilled water pumps.
 - 2. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:
 - a. Fiberglass: 2" thick for cold surfaces above 35 degrees F (2 degrees C) and 3" thick for surfaces 35 degrees F (2 degrees C) and lower.
 - b. Cellular Glass: 3" thick for surfaces above 35 degrees F (2 degrees C) and 4-1/2" thick for surfaces 35 degrees F (2 degrees C) and lower.
 - c. Flexible Elastomeric: 1" thick.

B. Hot Equipment (Above Ambient Temperature):

1. Application Requirements: Insulate the following hot equipment unless pre-insulated at factory:
 - a. Boilers.
 - b. Hot water storage tanks.
 - c. Heat exchangers.
 - d. Condensate receivers.
 - e. Hot water expansion tanks.
 - f. Hot water pumps.
 - g. Condensate pumps.
 - h. Fuel oil heaters.
 - i. Emergency generator silencers.
 - j. Flash tanks.
2. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:
 - a. Fiberglass: 2" thick, except 3" thick for low-pressure boilers and steam-jacketed heat exchangers.
 - b. Flexible Elastomeric: 1" thick. Do not use for equipment operating above 180 degrees F (82 degrees C) or 300F (149C) for high-temperature formula.

3.04 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Maintain continuous thermal and vapor-retarder integrity throughout entire installation unless otherwise indicated.
- C. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- D. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- E. Clean and dry pipe surfaces prior to insulating.
- F. Provide high density insulation material under supports or pre-insulated supports for cold piping. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers & Supports for HVAC Piping & Equipment" for pre-insulated supports and insulation shields.
 1. Insulation material shall extend a minimum 2 inches past the pipe shield on each side.
- G. Butt pipe insulation tightly at insulation joints. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band and coat all taped seams with vapor barrier coating to prevent moisture ingress.
- H. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 1. Insulate pipe elbows using fiberglass inserts with pre-molded PVC parts, preformed fitting insulation, or mitered fittings made from same material and density as adjacent pipe

- insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
2. Insulate tee fittings with fiberglass inserts with pre-molded PVC parts, preformed fitting insulation, or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 3. Insulate valves using fiberglass inserts with pre-molded PVC parts, preformed fitting insulation, or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 4. Insulate strainers using fiberglass inserts with pre-molded PVC parts, preformed fitting insulation, or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 5. Insulate flanges and unions using fiberglass inserts with pre-molded PVC parts or a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 6. Cover segmented insulated surfaces with a layer of finishing cement and finish with a coating or mastic. Install vapor-barrier coating for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the coating or mastic to a smooth and well-shaped contour.
 7. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 8. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
 9. Fittings on foam glass insulation shall be made up of mitered sections of foam glass.
 10. Fittings on fiberglass pipe insulation shall be mitered insulation up to 2" diameter and molded fittings for 2½" and larger. All indoor fitting insulation shall be covered with a tight fitting PVC jacket.
- I. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
 - J. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.
- K. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- L. Exterior Piping:
1. Encase piping insulation exposed to weather with one of the following:
 - a. Rigid aluminum shell with attachment bands spaced 12 inches on center and directly centered over end joints.
 2. Locate longitudinal seams of outer shell at bottom of pipe. Install cladding in strict conformance with cladding manufacturer's instructions and apply coatings in strict conformance with insulation manufacturer's instructions. Provide insulation shields so that the piping supports cannot puncture, cut or break the jacket.

3.05 INSTALLATION OF DUCTWORK INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation materials with smooth and even surfaces.
- C. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- D. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage,
- E. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.
- F. Cold Ductwork in Mechanical Rooms or Other Non-Conditioned Spaces: To prevent condensation from forming on the duct supports, provide one or more of the following:
1. Install thermal break such as rigid board insulation between the support and duct.
 2. Wrap support that is in contact with the duct with external duct wrap insulation to prevent condensation. Wrap shall extend a minimum of 12" from point of contact of the support with the duct. Coat all joints, punctures and seams with 4" wide coating of vapor barrier mastic.
 3. If a support device similar to unistrut is used, foam fill or stuff tube.
- G. Exterior Ductwork: Install ductwork with sufficient slope to ensure that water cannot pond anywhere on the duct. Drainage must be achieved by sloping ductwork – not by varying the

insulation thickness. Locate longitudinal seams of outer shell at bottom of duct. Install cladding in strict conformance with cladding manufacturer's instructions.

- H. Protect outdoor insulation from weather by installing outdoor protective weather barrier mastic and reinforcing mesh as recommended by manufacturer or protective jacket as specified. Install protective jacket in accordance with manufacturer's recommendations.
- I. Corner Angles: Except for oven and hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

3.06 THE INSULATION IS TO BE SECURED USING OUTWARD CLINCHING STAPLES ON DUCTWORK UP TO 36" WIDE AND STICK PINS ABOVE 36" WIDE. SEAL STAPLES AND PINS WITH MASTIC, NOT SELF-SEALED TAPE. INSTALLATION OF EQUIPMENT INSULATION

- A. General: Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.
- B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.
- C. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.
- D. Do not apply insulation to equipment, breechings, or stacks while hot.
- E. Apply insulation using the staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately. Tape all joints using a suitable, matching acrylic adhesive tape; minimum 3" wide.
- F. Coat insulated surfaces of calcium silicate with layer of insulating cement, troweled in workmanlike manner, leaving a smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
- G. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2". Apply over vapor barrier where applicable. Tape all joints using a suitable, matching acrylic adhesive tape; minimum 3" wide.
- H. Do not insulate boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.
- I. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

3.07 EXISTING INSULATION REPAIR

- A. Repair existing mechanical insulation that is damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.08 PROTECTION AND REPLACEMENT

- A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to moisture, deterioration, and physical damage.
- B. Replace damaged insulation which cannot be repaired satisfactorily, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation.

- C. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

3.09 PIPE INSULATION SCHEDULES

A. IECC – 2015 Requirements, Pipe Insulation

Fluid Operating Temp. Range (°F) And Usage	Minimum Pipe Insulation Thickness						
	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity, Btu·in./(hr·ft²·°F)	Mean Rating Temp., °F.	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
Insulation Thickness, in.							
>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	50	0.5	1.0	1.0	1.0	1.5

Notes:

- a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r\{(1 + t/r)^{(K/k)} - 1\}$ where
 - 1) T = minimum insulation thickness (in.),
 - 2) r = actual outside radius of pipe (in.),
 - 3) t = insulation thickness listed in this table for applicable fluid temperature and pipe size,
 - 4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./hr·ft²·°F); and
 - 5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
- b. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where safety issues, surface temperature, water vapor permeability, or surface condensation are a concern; or where noted on the drawings.
- c. For piping that shall be installed below grade, reference Division 23 section "Underground Hydronic and Steam Piping."
- d. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

B. IECC – 2012 Requirements, Pipe Insulation

Fluid Operating Temp. Range (°F) And Usage	Minimum Pipe Insulation Thickness						
	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity, Btu·in./(hr·ft²·°F)	Mean Rating Temp., °F.	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
Insulation Thickness, in.							

>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	75	0.5	1.0	1.0	1.0	1.5

Notes:

- a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r\{(1 + t/r)^{(K/k)} - 1\}$ where
 - 1) T = minimum insulation thickness (in.),
 - 2) r = actual outside radius of pipe (in.),
 - 3) t = insulation thickness listed in this table for applicable fluid temperature and pipe size,
 - 4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu-in./hr-ft²·°F); and
 - 5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
- b. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where safety issues, surface temperature, water vapor permeability, or surface condensation are a concern; or where noted on the drawings.
- c. For piping that shall be installed below grade, reference Division 23 section "Underground Hydronic and Steam Piping."
- d. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

C. IECC – 2009 Requirements, Pipe Insulation

Fluid	Minimum Pipe Insulation Thickness		
	Insulation Conductivity	Nominal Pipe or Tube Size (in.)	
	Conductivity, Btu-in./(hr-ft ² ·°F)	≤1-1/2	>1-1/2
Steam	≤0.27	1.5	3.0
Hot Water	≤0.27	1.5	2.0
Chilled Water, brine, or refrigerant	≤0.27	1.5	1.5

Notes:

- a. For insulation with a thermal conductivity greater than the stated conductivity limit at a mean temperature of 75°F, the minimum thickness (T) shall be determined as follows: $T = r\{(1 + t/r)^{(K/k)} - 1\}$ where

- 1) T = minimum insulation thickness (in.),
- 2) r = actual outside radius of pipe (in.),
- 3) t = insulation thickness listed in this table for applicable fluid and pipe size,
- 4) K = conductivity of alternate material at 75°F (Btu·in./hr·ft²·°F); and
- 5) $k = 0.27$ (Btu·in./hr·ft²·°F).

D. IECC – 2006 Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness			
Fluid	Insulation Conductivity	Nominal Pipe or Tube Size (in.)	
	Conductivity, Btu·in./hr·ft²·°F	≤1-1/2	>1-1/2
Steam	≤0.27	1.5	3.0
Hot Water	≤0.27	1.0	2.0
Chilled Water, brine, or refrigerant	≤0.27	1.0	1.5

E. ASHRAE 90.1 – [2013][2010] Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness							
Fluid Operating Temp. Range (°F) And Usage	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity, Btu·in./hr·ft²·°F	Mean Rating Temp., °F.	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
Insulation Thickness, in.							
>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.22–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	50	0.5	1.0	1.0	1.0	1.5

Notes:

- a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r\{(1 + t/r)^{(K/k)} - 1\}$ where
 - 1) T = minimum insulation thickness (in.),
 - 2) r = actual outside radius of pipe (in.),
 - 3) t = insulation thickness listed in this table for applicable fluid temperature and pipe size,
 - 4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./hr·ft²·°F); and
 - 5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

- b. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where safety issues, surface temperature, water vapor permeability, or surface condensation are a concern; or where noted on the drawings.
- c. For piping that shall be installed below grade, reference Division 23 section "Underground Hydronic and Steam Piping."
- d. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

F. ASHRAE 90.1 – 2007 Requirements, Pipe Insulation

Fluid Operating Temp. Range (°F) And Usage	Minimum Pipe Insulation Thickness						
	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity, Btu·in./(hr·ft ² ·°F)	Mean Rating Temp., °F.	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
	Insulation Thickness, in.						
>350°F	0.32–0.34	250	2.5	3.0	3.0	4.0	4.0
251°F–350°F	0.29–0.32	200	1.5	2.5	3.0	3.0	3.0
201°F–250°F	0.27–0.30	150	1.5	1.5	2.0	2.0	2.0
141°F–200°F	0.25–0.29	125	1.0	1.0	1.0	1.5	1.5
105°F–140°F	0.22–0.28	100	0.5	0.5	1.0	1.0	1.0
40°F–60°F	0.22–0.28	100	0.5	0.5	1.0	1.0	1.0
<40°F	0.22–0.28	100	0.5	1.0	1.0	1.0	1.5

Notes:

- a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r\{(1 + t/r)^{(K/k)} - 1\}$ where
 - 1) T = minimum insulation thickness (in.),
 - 2) r = actual outside radius of pipe (in.),
 - 3) t = insulation thickness listed in this table for applicable fluid temperature and pipe size,
 - 4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./hr·ft²·°F); and
 - 5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
- b. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where safety issues, surface temperature, water vapor permeability, or surface condensation are a concern; or where noted on the drawings.
- c. For piping that shall be installed below grade, reference Division 23 section "Underground Hydronic and Steam Piping."
- d. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer

per foot than a steel pipe of the same size with the insulation thickness shown on the table.

G. California Building Efficiency Standards (Title 24 – Part 6) Requirements, Pipe Insulation

Fluid Operating Temp. Range (°F) And Usage	Minimum Pipe Insulation Thickness						
	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity, Btu·in./(hr·ft²·°F)	Mean Rating Temp., °F.	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
Insulation Thickness, in.							
>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.22–0.28	100	1.0	1.5	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	50	1.0	1.5	1.5	1.5	1.5

Notes:

- a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r\{(1 + t/r)^{(K/k)} - 1\}$ where
 - 1) T = minimum insulation thickness (in.),
 - 2) r = actual outside radius of pipe (in.),
 - 3) t = insulation thickness listed in this table for applicable fluid temperature and pipe size,
 - 4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./hr·ft²·°F); and
 - 5) k = the lower value of the conductivity range listed in this table for the applicable fluid temperature.
- b. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where safety issues, surface temperature, water vapor permeability, or surface condensation are a concern; or where noted on the drawings.
- c. For piping that shall be installed below grade, reference Division 23 section "Underground Hydronic and Steam Piping."
- d. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

END OF SECTION 23 07 00

SECTION 23 08 00 COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 Scope

- A. Work under this Section is subject to requirements of the Contract Documents including Divisions 00 and 01.

1.2 Description

- A. Commissioning is a systematic process of ensuring the HVAC systems perform interactively according to the design intent and Owner's operational needs. Commissioning will encompass and coordinate traditionally separate functions of system documentation, installation checkout, equipment startup, control system calibration and point-to-point checkout, testing and balancing, and functional performance testing. Commissioning is intended to achieve the following specific objectives according to the Contract Documents:
1. Verify systems are in accordance with the plans and specifications.
 2. Verify and document proper installation and performance of equipment and systems.
 3. Ensure O&M, maintenance training, and commissioning documentation requirements are complete.
 4. Provide Owner with functional buildings and/or systems with minimal operational problems at time of move-in.
- B. Commissioning does not take away from or reduce responsibility of system designers or installing contractors to provide a finished and fully functioning product.
- C. This section shall in no way diminish the responsibility of the Division 23 Sub-contractors and Suppliers in performing all aspects of work and testing as outlined in the contract documents. Any requirements outlined in this section are in addition to requirements outlined in Division 23 Specifications.

1.3 Abbreviations

- A. The following are common abbreviations used in the Specifications. Definitions are found further in this Section.

Abbreviation	Full Name	Additional Information
A/E	Architect and Design Engineers	The HVAC Engineer
BAS	Building Automation System	
CA	Commissioning Agent	An employee or agent of the GC
CM	Construction Manager	HCA Construction Manager

Abbreviation	Full Name	Additional Information
CT	Commissioning Team	
Cx	Commissioning	
CC	Controls Contractor	
DFM	HCA Director of Facility Management	
EC	Electrical Contractor	
FPT	Functional Performance Test	
GC	General Contractor	
MC	Mechanical Contractor	
OR	Owner's Representative	
PC	Pre-functional Checklist	
TAB	Test, Adjust and Balance	
O&M	Operations & Maintenance	
RFI	Request for Information	

1.4 Related Work

- A. Specific commissioning requirements are given in the following sections of these specifications. The following sections apply to work specified in this section.

1. Section 23 08 00 - Commissioning

1.5 Coordination

- A. Commissioning Team: Members of the Commissioning Team (CT) will consist of:
1. Commissioning Agent (CA)
 2. Owner's Representative(s) (OR)
 3. Construction Manager (CM)
 4. Architect and Design Engineers (A/E)
 5. Mechanical Contractor (MC)
 6. Electrical Contractor (EC)
 7. Test and Balance Contractor (TAB Contractor)
 8. Controls Contractor (CC)
 9. Equipment Suppliers and Vendors
- B. Management: The CA directs and coordinates commissioning activities. All members of the Commissioning Team shall cooperate to fulfill contracted responsibilities and objectives of the Contract Documents.

C. **Kick-off Meeting:** Within 90 days of commencement of construction, CA and OR will plan, schedule and conduct a commissioning kick-off meeting. Membership and responsibilities of the commissioning team will be clarified at this meeting. CA will distribute meeting minutes to all parties.

D. **Scheduling:**

1. CA and OR will work with commissioning team to establish required commissioning activities to incorporate in preliminary commissioning schedule. The CA and GC will integrate commissioning activities into the master construction schedule. Representatives of the commissioning team will address scheduling problems. Necessary notifications are to be made in a timely manner in order to expedite commissioning.
2. The CA and OR will provide initial schedule of primary commissioning events at commissioning kick-off meeting. As construction progresses, more detailed schedules are developed by the CA.

1.6 Definitions

- A. **Acceptance Phase:** Phase of construction after startup and initial checkout when Functional Performance Tests, O&M documentation review and training occur.
- B. **Approval:** Acceptance that a piece of equipment or system has been properly installed and is functioning in tested modes according to the Contract Documents.
- C. **Architect/Engineer (A/E):** Prime consultant (architect) and sub-consultants who comprise the design team, generally HVAC Mechanical Designer/Engineer and Electrical Designer/Engineer.
- D. **Commissioning Agent (CA):** An assigned employee or agent of the GC. CA directs and coordinates day-to-day commissioning activities.
- E. **Contract Documents:** Documents binding on parties involved in construction of this project (drawings, specifications, change orders, amendments, contracts, etc.).
- F. **Control System:** System and components associated with building automation system.
- G. **Construction Manager (CM):** Owner's employee assigned the responsibility of managing the overall project.
- H. **Deferred Functional Tests:** Functional tests performed after substantial completion due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow test from being performed.

- I. Deficiency: Condition of a component, piece of equipment or system that is not in compliance with Contract Documents (that is, does not perform properly or is not complying with design intent).
- J. Director of Facility Management (DFM): Facility employee responsible for the maintenance of the Physical Plant.
- K. Factory Testing: Testing of equipment on-site or at factory, by factory personnel.
- L. Functional Performance Test Procedures: Commissioning protocols and detailed test procedures and instructions that fully describe the steps required to determine if the system is performing and functioning properly. These procedures are written by the A/E and shall be used to document Functional Performance Tests. They shall be included in the Project Manual.
- M. Functional Performance Test (FPT): A demonstration of the dynamic function and operation of equipment and systems. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, life safety conditions, power failure, etc. Systems are run through all specified sequences of operation. Components are verified to be responding in accordance with contract documents. The test results are both manually recorded on the FPT Procedure and with trending data using the BAS. Functional Performance Tests are executed after pre-functional checklists and startups are complete.
- N. General Contractor: Contracted directly to Owner. Sub-contractors report to the General Contractor.
- O. Indirect Indicators: Indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100% closed.
- P. Manual Test: Using hand-held instruments, immediate control system readouts, or direct observation to verify performance (contrary to analyzing monitored data taken over time to make "observation").
- Q. Monitoring: Recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or trending capabilities of control systems.
- R. Non-Compliance: See Deficiency.
- S. Non-Conformance: See Deficiency.
- T. Overridden Value: Writing over a sensor value in the control system to see response of a system (e.g., changing outside air temperature value from 50°F to 75°F to verify economizer operation). See also "Simulated Signal".
- U. Owner's Representative (OR) – An employee of the Owner or person contracted with the Owner to provide Cx Verification Services. The responsibility of the OR is to assist the Cx Team in understanding the Cx

- requirements of the project, monitor the Cx progress through site visits and Cx Team Meetings, review the completed Cx Pre-Functional Performance Checklists and Functional Performance Test for completeness, perform Cx verification testing as appropriate to determine that the Cx requirements of the project have been successfully completed.
- V. Owner Verification: A repeat of the FPTs in the presence of the OR and A/E. The OR will determine if only selected or all FPTs will be repeated based on his inspection and review of the Cx documentation submitted by the CA prior to this visit. Typically the length of this visit is less than 3 days. On phased projects, phased commissioning may be required.
- W. Phased Commissioning: Commissioning completed in phases (by floors, for example) due to size of structure or other scheduling issues.
- X. Pre-functional Checklist (PC): 1) A list of static inspections and elementary component tests that verify proper installation of equipment (e.g., belt tension, oil levels, labels affixed, gages in place, sensors calibrated, etc.). 2) Pre-functional Checklists may also include startup tests that prepare equipment and system for functional operation. 3) A summary of specified documentation is presented in checklist format. The A/E shall include the PCs in the Project manual.
- Y. Seasonal Performance Tests: Functional Performance Tests or parts thereof that are deferred until system(s) ambient conditions are closer to design conditions in order to verify proper system operation.
- Z. Simulated Condition: Condition created for testing component or system (e.g., applying heat to space temperature sensor to monitor response of VAV box).
- AA. Simulated Signal: Disconnecting a sensor and using a signal generator or a software value to simulate an input value to the BAS.
- BB. Specifications: Construction specifications of Contract Documents.
- CC. Startup: The activities where systems or equipment are initially tested and operated. Startup is completed prior to functional testing.
- DD. Sub-contractor: Contractors of GC, and their sub-contractors, who provide and install building components and systems.
- EE. Test Procedures: Step-by-step processes, which must be executed to fulfill test requirements.
- FF. Test Requirements: Requirements specifying what modes and functions, etc. will be tested.
- GG. Trending: Recording of parameters (flow, temperature, pressure, status, etc.) during system operation using the BAS.
- HH. Vendor: Supplier of equipment.

- II. Warranty Period: Warranty period for entire project, including equipment components.

1.7 Submittals

- A. CA shall provide the OR and A/E an "as-built" controls submittal 5 working days prior to the scheduled Owner's Verification visit. The submittal shall include the full sequences of operation that describe the actual controls programming.

1.8 Start-Up

- A. Sub-contractor responsible for purchase, installation and startup of equipment shall perform the manufacturer's detailed startup and checkout procedures in addition to the PCs.
- B. GC/Sub-contractor shall compile documentation and recording forms for all testing and start-up required by Division 22, 23, and 26 specifications (e.g. duct pressure testing, duct cleaning, pipe pressure testing, piping flushing and cleaning plans, electrical testing, etc.). Testing documentation shall include:
1. Completed test forms
 2. Completed Start-up forms
 3. Equipment Maintenance Log

PART 2 - PRODUCTS

2.1 Test Equipment

- A. Division sub-contractors shall provide all specialized tools, test equipment and instruments required to execute startup, checkout and functional performance testing of equipment under their contract.
- B. Test equipment shall be of sufficient quality and accuracy to test and/or measure system performance with tolerances specified. A testing laboratory shall have calibrated test equipment within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be calibrated according to manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 Commissioning Overview

The following provides a brief overview of typical commissioning tasks during construction and the general order in which they occur:

- A. Commissioning during construction begins with a kick-off meeting conducted by CA and OR where membership of commissioning team is established, responsibilities reviewed, and the Cx scope and procedures are reviewed. A preliminary commissioning schedule is distributed for review.
- B. CA schedules subsequent meetings as necessary to plan, coordinate and schedule commissioning activities. Deficiencies and problem resolution will also be discussed at these meetings.
- C. CA develops, with cooperation of sub-contractor/vendor, detailed training plan. The CA schedules training activities with the facility's staff.
- D. CA supervises the execution of the PCs completed by the subcontractors. PCs shall be completed for a piece of equipment prior to scheduling startup.
- E. CA will witness startup of selected equipment. Startup Reports will be kept in the Start-Up Binder for review.
- F. Sub-contractors complete testing (e.g. duct and piping pressure testing, piping flushing, etc.) as required by Division 1, 22, and 23 specifications. Sub-contractors compile copies of completed testing documentation in the Start-Up Binder for CA and OR review.
- G. Sub-contractors perform start-up and initial checkout Sub-contractors assemble completed Start-Up Plan documentation and submit to CA for verification of completion of start-up activities prior to functional performance tests.
- H. CA assembles the Cx team for a step by step review of the FPT procedures in advance of the execution of the first FPT. The A/E shall lead this review and immediately update any FPT that requires changes.
- I. Functional testing is completed after TAB is completed.
- J. A/E shall be present to assist in the execution of the first FPT. The CA shall coordinate the schedule for this test to coincide with the A/E's scheduled trip to attend an Owner-Architect-Contractor meeting.
- K. Functional Performance Tests are executed by sub-contractors, under supervision of and documented by CA.

- L. CA is responsible for having the completed FPT procedures, the specified trending data, the final T&B report, and the "as-built" control submittal to the OR and A/E not less than 5 working days prior to the scheduled Owner's Verification visit.
- M. All the FPTs must be completed and the Owner's Verification must occur prior to occupancy unless otherwise directed by the CM. (Owner Verification may be waived on some phases of a phased project; however, the FPTs and controls submittal must be submitted to the OR prior to occupancy.)
- N. Items of non-compliance in material, installation or setup will be corrected at sub-contractor expense and system shall be retested.

3.2 Systems To Be Commissioned

A. Mechanical:

1. Air Handling systems including air handlers, air terminal boxes, energy recovery systems, exhaust fans and ancillary equipment
2. Chilled water system including chillers, cooling towers, pumps, and ancillary equipment
3. Steam system and components serving HVAC system
4. Heating Hot Water system including boilers, convertors, pumps and ancillary equipment
5. Building Automation System

B. Plumbing:

1. Domestic Hot Water Recirculation System

C. Electrical:

1. Emergency Generator

3.3 Responsibilities

Responsibilities of commissioning team members are:

A. Architect/Engineer (A/E):

1. Develop detailed PCs.
2. Develop detailed project specific FPT procedures.
3. Review FPTs in detail with the Cx Team.
4. Witnesses first run of first FPT.
5. Review all Cx documentation, including TAB reports, and provide written comments to the OR and CA within 5 days of receipt.

B. Commissioning Agent (CA):

1. Coordinate and direct commissioning activities in a logical, sequential and efficient manner.
2. Schedule and chair Cx kick-off meeting and issue minutes.
3. Incorporate commissioning activities into master construction schedule.
4. Schedule and chair all commissioning team meetings and issue minutes.
5. Provide progress reports of commissioning status.
6. Periodically update commissioning schedule.
7. Supervise completion of Pre-functional Checklists and supporting documentation to verify systems readiness for Functional Performance Testing.
8. Supervise Functional Performance Tests. Document test results and recommend system for acceptance.
9. Review completed TAB reports.
10. Develop, with cooperation of sub-contractor/vendor and DFM, a detailed training plan.
11. Schedule and oversee training sessions.
12. Prepare final Commissioning Turnover Documentation.

13. Facilitate cooperation of sub-contractors in commissioning work.
14. Forward completed TAB report, as-built controls submittal, FPT procedure, and trend data to OR and A/E and at least 5 working days prior to scheduled Owner Verification visit.
15. Identify, track and coordinate resolution of non-compliance and deficiencies identified by commissioning team. Maintain records of all issues submitted by commissioning team.
16. Coordinate sub-contractor/vendor participation in training sessions. Provide workspace or conference room as needed. Ensure attendance at training is documented.
17. Schedule, coordinate and assist CT in seasonal or deferred testing.

C. Sub-contractors/Vendors:

1. Review PCs and Functional Performance Test procedures.
2. Attend commissioning kick-off meeting and other commissioning team meetings.
3. Ensure installation work is complete, is in compliance with Contract Documents and is ready for Functional Performance Testing.
4. Execute Pre-functional Checklists and submit in electronic format with supporting documentation to CA and OR prior to startup of equipment.
5. Execute all required equipment and systems testing as required by project specifications (e.g. duct pressure testing, piping pressure testing, piping flushing, etc.). Provide schedule of testing activities to CA prior to start of any testing so that CA may witness a sampling of the testing as required. Submit completed testing documentation in final executed Start-Up binder to CA and OR for review prior to start of functional testing.
6. Execute all periodic maintenance required on started equipment from initial start-up of equipment to final acceptance by Owner to prevent equipment warranties from being voided. Document execution of periodic maintenance by signing and dating maintenance logs for each item of equipment.
7. Execute Functional Performance Tests as described in contract documents.
8. Provide certified and calibrated instrumentation required to take measurements of system and equipment performance during Functional Performance Testing.
9. Assist CA with developing a comprehensive commissioning schedule.

10. Execute seasonal or deferred Functional Performance Testing.
11. Make necessary amendments to O&M manuals and as-built drawings/submittals for applicable issues identified in the Cx process.
12. Support the testing that occurs during the Owner's Verification visits.

D. Controls Contractor (CC):

1. Attend commissioning kick-off meeting and other commissioning team meetings.
2. Completely install and thoroughly inspect startup, test, adjust, calibrate and document systems and equipment under BAS Contract.
3. Provide laptop computer, software and training to accommodate TAB Contractor in system balancing.
4. Maintain database of control parameters submitted by TAB Contractor subsequent to field adjustments and measurements.
5. Provide on-site technician skilled in software programming and hardware operation to exercise sequences of operation and to correct control deficiencies identified during Functional Performance Testing and Owner's Verification.
6. Provide instrumentation, computer, software and communication resources necessary to demonstrate total operation of building systems during Functional Performance Testing and Owner's Verification of control system equipment.
7. Maintain comprehensive system calibration and checkout records. Submit records to CA upon request.
8. Submit executed copies of the commissioning functional tests (signed and dated by the control Sub-contractor technician directly responsible for verification of the control sequence or system operation) prior to Owner's Verification (to show that the control Sub-contractor has actually tested and verified each sequence prior to CA witnessing the functional testing).
9. Setup trend logs as requested by CA to substantiate proper systems operation.
10. Prepare the required trending information and submit to the CA.
11. Provide on-site technician skilled in software programming and hardware operation to exercise sequences of operation and to correct control deficiencies identified during Opposed Season Functional Performance Testing.

E. Test, Adjust and Balance (TAB) Contractor:

1. Attend commissioning kick-off meeting and other commissioning team meetings.
2. Complete test and balance procedures prior to functional performance testing.
3. Cooperate with CC with execution of required work.
4. Submit copy of final TAB report to CA for review prior to Owner's verification visit.
5. Rebalance deficient areas identified during commissioning.
6. Provide on-site technician, as necessary, skilled in TAB procedures to provide limited system TAB readings during Functional Performance Testing and Owner's Verification.
7. Provide on-site technician skilled in software programming and hardware operation to exercise sequences of operation and to correct control deficiencies identified during Opposed Season Functional Performance Testing.

3.4 Commissioning Team Meetings

- A. Commissioning team meetings will be held periodically as determined by CA and OR with frequency increasing as construction advances and systems become operational. Attendance is mandatory. CA will record minutes and attendance. CA will chair Commissioning Team Meetings.
- B. Discussions held in Commissioning Team Meetings shall include, but not be limited to system/equipment startup, progress, scheduling, testing, documentation, deficiencies and problem resolution.

3.5 Reporting

- A. CA will at OAC meetings provide regular status reports to CM and A/E.
- B. CA will regularly communicate with members of commissioning team, keeping them apprised of commissioning progress.
- C. CA shall submit non-compliance and deficiency reports to the CM.

3.6 Pre-Functional Checklists

- A. The objective of the Pre-Functional Checklist is to verify and document that the equipment/systems are provided and installed according to documented design intent and Contract Documents.
- B. Pre-functional checklists are provided by the A/E and executed as the work is completed in phases by the installing Sub-contractors. The project specific Pre-functional checklists are included at the end of this section by the A/E. GC and Sub-contractors shall review final construction documentation for

applicable details and specifications related to equipment to be commissioned in order to fully ascertain all of the pre-functional checklist requirements.

- C. The contractors will execute the pre-functional checklists in phases as work is completed such as setting equipment, piping equipment, insulating it, making up electrical connections, etc. The purpose is to execute the commissioning process and complete the checklists as the work is being completed and not to wait until the end of the installation to complete the checklists.
- D. The Mechanical Contractor's field foreman shall inspect each piece of installed HVAC equipment using the appropriate Pre-functional Checklist. He shall initial and date each item when it passes inspection and re-inspect until all items pass.
- E. When all items have successfully passed inspection the Mechanical Contractor's superintendent and the General Contractor's project manager shall separately inspect, sign and date the checklists to verify that the installation is complete.
- F. The GC will maintain a single "master" hard copy of the PFC checklists executed by the Sub-contractors on-site for CT review during periodic site visits.

3.7 Startup And Initial Checkout

- A. CA shall schedule equipment startup after the PCs are executed and documented by Sub-contractor. Startup shall not occur until after the CA and sub-contractors have reviewed the completed PCs.
- B. Sub-contractor to prepare an overall schedule of testing and start-up activities in advance and forward to OR so that OR can witness start-up activities as required
- C. OR reserves the right to witness any startup or equipment testing. DFM shall be contacted and invited to witness all equipment startup.
- D. CA shall provide OR with signed and dated copy of completed startup and pre-functional checklists. Only individuals having direct knowledge that a line item task was actually performed will initial or check that item off.
- E. CA shall clearly list outstanding items or initial startup and pre-functional procedures not completed successfully.
- F. CA shall review deficiency reports to determine if outstanding items prevent scheduling of Functional Performance Testing.

3.8 Functional Performance Testing

- A. Objectives and Scope:

1. The objective of Functional Performance Testing is to demonstrate each system is operating according to documented design intent and Contract Documents. Functional Performance Testing facilitates bringing systems from a state of substantial completion to full dynamic operation. Additionally, during Functional Performance Testing, areas of deficient performance are identified and corrected, improving operation and functioning of systems.
2. Each system shall be operated through all modes of operation where there is a specified system response. Verifying each sequence in the sequences of operation is required.

B. Development of Test Procedures:

1. The purpose of any given specific test is to verify and document compliance with stated criteria of acceptance given on test form. A/E shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Prior to execution, the CA will review the FPT procedures with the A/E and Cx Team (i.e. answering questions about equipment, operation, sequences, etc.). CA shall provide a copy of test procedures to Sub-contractor. Sub-contractor will review tests for feasibility, safety and equipment warranty protection. CA shall also submit tests to Owner, CM and A/E and other commissioning team members for review.
2. Examples of test procedure forms to be developed by the A/E are included herein.

C. Coordination and Scheduling:

1. CA will conduct a step by step table top review of the FPT procedures with the CT weeks in advance of the first FPT.
2. CA shall witness and document functional testing of equipment and systems. Sub-contractor shall execute tests under direction of CA.
3. Functional Performance Testing is conducted after system operation and checkout is satisfactorily completed. Air balancing and water balancing is to be completed and debugged before functional testing of air-related or water-related equipment or systems.
4. CA will schedule Owner's Verification visit with the OR and A/E after completion of functional performance test procedures by the CA.
5. CA will transmit the completed FPT procedures, associated trend data, TAB report, and "as-built" control submittal to the OR and A/E on a schedule that will give them five working days to review this information prior to the scheduled Owner's Verification visit.

3.9 Documentation, Non-Conformance And Approval Of Tests

A. Documentation:

1. CA will witness and document the results of the FPTs using specific Functional Performance Test procedures developed for that purpose. CA will include filled out FPTs in Commissioning Turnover Package.

B. Non-Conformance:

1. CA will record results of functional performance testing. Deficiency or non-conformance issues will be noted and reported to A/E and OR on notes section of the FPT procedure.
2. Corrections of minor deficiencies identified may be made during tests at discretion of CA. In such cases, deficiency and resolution will be documented on FPT form.
3. Every effort will be made to expedite testing and minimize unnecessary delays, while not compromising integrity of tests. CA shall not overlook deficient work or loosen acceptance criteria to satisfy scheduling or cost issues unless directed to do so by the OR.
4. Deficiencies are handled in the following manner:
 - a. When there is no dispute on deficiency and Sub-contractor accepts responsibility for remedial action:
 - i. CA documents deficiency.
 - ii. CA reschedules test with Sub-contractor.
 - b. When there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
 - i. CA documents deficiency and the sub-contractor's response and they go on to another test or sequence.
 - ii. CA facilitates resolution of deficiency. Other parties are brought into discussions as needed. Final interpretive authority is with A/E. Final acceptance authority is with the OR.
 - iii. CA documents the resolution.

C. Approval:

1. CA notes each satisfactorily demonstrated function on test form. CA, A/E and OR provide formal approval of FPT. CA recommends acceptance of each test to A/E and OR. The OR maintains a Cx Issues Log that documents the issues/problems that arise during Cx Verification. The OR and A/E work together to update the log until all the issues are resolved to the satisfaction of the OR. The OR notifies

the CM when the Cx Issues are resolved to the extent that occupancy by the Owner can occur.

3.10 Commissioning Documentation

A. Commissioning Turnover Package

1. CA is responsible to compile and organize commissioning records. CA shall deliver Cx records to the OR in Commissioning Binders. Turnover Package to include the following:
 - a. "As-built" controls submittal
 - b. Pre-functional Checklists
 - c. Start-Up Binder with completed testing and start-up reports
 - d. Completed Functional Performance Test records
 - e. Trend data
 - f. A list of deficiencies referenced to a specific FPT section
 - g. Final TAB Report

3.11 Training Of Owner Personnel

- A. Sub-contractors will provide complete training in startup, operation and maintenance of all equipment under contract.
- B. CA will be responsible for overseeing and approving content and adequacy of Facility Staff training.
- C. Sub-contractor responsible for training will submit a written training plan to CA for review and approval prior to training. Plan will cover the following elements:
 1. Equipment (included in training)
 2. Intended audience
 3. Location of training
 4. Objectives
 5. Subjects covered
 6. Duration of training on each subject
 7. Instructor for each subject
 8. Methods (classroom lecture, video, site walk-through, actual operational demonstrations, written handouts, etc.)
 9. Instructors and qualifications

- D. CA coordinates and schedules training with CM, DFM and Sub-contractors. CA develops criteria to determine training satisfactorily completed. CA schedules training sessions with appropriate personnel.
- E. CA will provide videotaping of training sessions as required.

3.12 Deferred Testing

A. Deferred Seasonal Testing:

- 1. During warranty period, seasonal testing (tests delayed until weather conditions are closer to system's design) will be completed as part of this contract. CA will coordinate this activity. Tests will be executed, documented and deficiencies corrected by appropriate contractor(s), with DFM, OR and CA witnessing. CA will incorporate final updates to Commissioning Turnover Package as necessary.

B. Unforeseen Deferred Tests:

- 1. Any check or test not completed due to building structure, required occupancy condition, or other deficiency, may be delayed upon approval of OR. These tests will be rescheduled as soon as possible.

3.13 Functional Performance Tests And Test Procedures

- A. AHU Functional Performance Test – The AHU FPT is to be conducted after the hydronic water balance and air side T&B for the spaces served by the AHU are complete. Portions of this FPT also require that the chilled water and heating water systems operate to produce chilled water and heating water at design temperatures. The AHU FPT requires a 24 hour trend at 3 minute intervals of AHU and chilled water system parameters listed in the FPT procedure. The trending should be scheduled to ensure that fire alarm tests or other activities do not shut down the AHU or hydronic systems during the 24 hour period.

In the Functional Performance Tests Section (Tab 3) there is an example of AHU FPT (including templates for calculating and displaying the trend data) for the AHU sequence of operation contained in this document (see BAS AHU with and without Preheat Coil Schematic and Sequence of Operation Sections, Tabs 8 and 9). The design consultant is responsible for including in this section of the Project Manual a comprehensive, accurate, and clearly written AHU FPT that is specific to the sequence of operation specified.

- B. Air Terminal Unit Functional Performance Tests – Two tests are performed on the Air Terminal Units: a Heating Mode Test and a Cooling Mode Test. Completion of the AHU FPT is a prerequisite to performing these tests. The VAV/CAV Air Terminal Unit Heating and Cooling tests are to be conducted after the hydronic water balance and air side T&B for the terminal units and the AHUs serving these units are completed. These FPTs also require that

the chilled water and heating water systems produce design chilled water and heating water temperatures of typically 42°F and 140°F, respectively, continuously throughout the tests. Coordinate with other trades to insure that the chilled water, heating water, and AHUs involved will operate without interference throughout the duration of the tests, approximately 5 hours for each test. An effort should be made to keep all doors separating the terminal boxes' zones closed during these tests. The Air Terminal Unit FPT can be conducted simultaneously for all the terminal units in the project or selected terminal units may be tested separately from others provided the chilled water system, heating hot water system, and the AHU serving the units meet the prerequisites for conducting the test.

The Heating Mode test is to be performed prior to the Cooling Mode test. The space thermostats involved in the Heating Mode test are to be set at 72°F at least 5 hours immediately prior to beginning the Heating Mode test. This is done to establish steady state temperature conditions prior to raising the space thermostats to a set point of 76°F.

When the building has been given time to stabilize at 72°F begin trending the required parameters. Trend each data point every 3 minutes.

Thirty minutes after beginning the trending of parameters globally change the thermostat set point of the boxes being tested to 76°F. Continue trending for another 5 hours. This completes the Heating Mode Test. The information requested on the Heating Mode Test form (see Functional Performance Test Procedures Section, Tab 3) is only supplied for terminal boxes that do not meet the test criteria specified at the bottom of the form.

The Cooling Mode Test should immediately follow the Heating Mode Test. Globally set the thermostat set point of the boxes being tested to 68°F and continue trending the same parameters for 4½ hours.

If the Cooling Mode Test does not immediately follow the Heating Mode Test, 5 hours prior to starting the Cooling Mode Test adjust the thermostat set point for the terminal units being tested to 74°F. After the 5 hour stabilization period, begin trending the parameters specified in the test form. Thirty minutes after beginning the trending, globally change the thermostat set point of the terminal units being tested to 69°F. Continue trending for another 5 hours.

The trend data is to be presented as tabular data in an Excel workbook. The data for each terminal unit is to be contained in separate work sheets using

the unique terminal unit designation as the name for each sheet. The columns of each work sheet are to be ordered from left to right as follows:

Date and time in ascending order, zone thermostat set point, cooling set point, heating set point, actual zone temperature, terminal unit reheat coil discharge air temperature, reheat valve commanded position, actual cfm, heating cfm set point, cooling cfm set point, commanded damper position, AHU discharge air temperature, AHU static pressure, and heating hot water supply temperature. Shade data of the Heating Mode Test red and the Cooling Mode Test data blue.

The system trend data, AHU discharge air temperature, AHU static pressure, chilled water valve control position, building chilled water supply temperature, building heating hot water supply temperature, and outside air temperature are to be combined in a separate worksheet for each AHU.

Heating Mode and Cooling Mode test forms and templates for calculating and displaying the trend data are included in the Functional Performance Tests Section (Tab 3). These sheets are to be completed for the terminal units that fail the initial FPT or any subsequent FPT.

- C. Chilled Water System Functional Performance Test – The Chilled Water System FPT is conducted after chiller startup, hydronic TAB, and the AHU chilled water control valves are under automatic control. This FPT must test or demonstrate: user change of the order in which the chillers are staged; automatic start of the lead chiller; automatic start of the lag chillers in sequence; automatic de-staging of the lag chillers in sequence; automatic staging and control of pumps and pump speeds; the ability of the system to maintain minimum chiller flow; calibration of the chilled water system sensors.

In the Function Performance Tests Section (Tab 3) there is an example of a Primary/Secondary Chilled Water System FPT. The design consultant is responsible for including in this section of the Project Manual a comprehensive, accurate, and clearly written Chilled Water System FPT that is specific to the sequence of operation specified.

- D. BAS/ESC connectivity Functional Performance Test – Coordinate with HCA corporate FacilitiGroup Energy Service center to verify full BAS communication between the facility and ESC.

3.14 Pre-Functional Checklists

***Note to Specifying Engineer: Include PFT Checklists in the Project Manual ***
See Appendix A-2: Pre-Functional Checklists.

3.15 Functional Performance Test Procedures

***Note to Specifying Engineer: Include PFT Checklists in the Project Manual ***
See Appendix A-3: Functional Checklists.

END OF SECTION 23 08 00

SAMPLE CHECKLISTS

SECTION 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Control panels.
- B.
- C. Control valves.
- D. Control dampers.
- E. Operators.
- F. Flow measuring apparatus.
- G. Humidistats.
- H. Input/Output sensors and transmitters.
- I. Output control devices.
- J. Power Supplies.
- K. Room pressure controller.

1.02 DEFINITIONS

- A. BAS: Building Automation System.
- B. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and IP switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operations
- C. Cv: Design Valve Flow Coefficient.
- D. DDC: Direct Digital Control.
- E. EPDM: Ethylene Propylene Diene Monomer.
- F. High voltage: 50 volts or higher.
- G. Low voltage: Below 50 volts.
- H. PTFE: Polytetrafluoroethylene.
- I. TEFZEL: A modified ETFE (ethylene tetrafluoroethylene) fluoroplastic.

1.03 CONTRACTOR RESPONSIBILITIES

- A. Reference Division 23 Section "Electrical Coordination for Mechanical Equipment" for contractor responsibilities.
- B. BAS Contractor:
 - 1. Installation of the BAS shall be by the BAS Contractor or their subcontractors.
 - 2. Low voltage control wiring.
 - 3. Coordinate high voltage control wiring to instrumentation and control devices with Division 26. Where high voltage power is required for instrumentation and control devices that is in addition to what is shown on the drawings, the BAS contractor shall cover the cost of providing this wiring.
 - 4. All interlock wiring regardless of voltage (e.g., exhaust fan interlocked to supply fan).
 - 5. Coordinate with Division 26 that motor starters are provided with auxiliary contacts as required for interlocks.
 - 6. Coordinate power wiring to BAS controllers and instrumentation and control devices with Division 26.

7. Coordinate installation of back-box rough-in for wall-mounted control devices sensors, etc. with Division 26. Coordinate with mechanical contractor all locations, quantities, and sizes required for installation by Division 26.
8. Perform startup and demonstration services as specified in Section "Direct Digital Control for HVAC".
- C. Sheet Metal Contractor:
 1. Installation of automatic control dampers, smoke control dampers, and necessary blank off plates.
 2. Access doors where and as required.
- D. Mechanical Contractor:
 1. Installation of immersion wells.
 2. Installation of flow switches.
 3. Installation of automatic control valves.
 4. Installation of pressure tappings and associated shut-off cocks.
 5. Coordinate conduit and wall box rough-in, power wiring and magnetic starter requirements for controls and mechanical equipment with Division 26.

1.04 SUBMITTALS

- A. Refer to Division 01 for submittal procedures.
- B. Product Data: Provide description and engineering data for each control system component. Include dimensions, capacities, size, performance characteristics, electrical characteristics, and finishes of materials.
- C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
- D. Schedule for control valves and actuators, including the following:
 1. Tag.
 2. Quantity.
 3. Model number.
 4. Equipment served.
 5. Flow at project design conditions.
 6. Selected valve flow coefficient (Cv). For butterfly valves, submit the corresponding valve position at which the Cv is calculated.
 7. Pressure differential drop across valve at project design flow conditions and selected Cv.
 8. Maximum close-off pressure.
 9. Valve Configuration (2-way/3-way).
 10. Valve Normal Position and Fail Position (e.g., NO/FO; normally open/fail open).
 11. Valve Size.
 12. Line Size.
 13. Valve Type.
 14. Actuator Signal Type (Open/Close, Modulating 0-10 Vdc, 2-10 Vdc, 4-20 mA, etc.)
 15. Torque required to close valve at pump shutoff head.
 16. Selected actuator maximum torque output.
- E. Manufacturer's Instructions: Provide for all manufactured components.
- F. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

- G. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
- H. Warranty: Submit manufacturer warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
- C. Control valves shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ANSI and MSS standards.
- D. Measurement devices and sensors shall be calibrated using NIST traceable standards.

1.06 WARRANTY

- A. Correct defective Work within a one year period after Substantial Completion.
- B. Provide extended warranty for control devices and equipment as specified herein.

PART 2 - PRODUCTS

2.01 CONTROL PANELS

- A. Construction:
 - 1. Panel shall be UL 508A listed.
 - 2. NEMA 250, general purpose utility enclosures with enameled finished face panel.
 - 3. NEMA 4X utility enclosure for outdoor or wash-down applications.
 - 4. Provide common keying for all panels.

2.02 CONTROL VALVES

- A. General:
 - 1. Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated. Each valve shall be equipped with proper packing to ensure there will be no leakage at the valve stem.
 - 2. Pressure Ratings:
 - a. Valve body and packing rated to withstand the system static head plus the maximum pump head and the maximum temperature of the control medium (i.e. chilled water, steam, hot water, etc.).
 - 1) Minimum pressure class 150 psig.
 - b. Two-way modulating valves and their operators shall have close-off pressure ratings exceeding the dead-head condition of the pump in the system it serves.
 - c. Two-way modulating valves with equal percentage flow characteristics and their operators shall be rated to safely operate within a differential pressure range between 2 and 50 psi across the valve without cavitating.
 - 3. Sizing:
 - a. Hydronic Systems:
 - 1) Two-Position: Line size or sized using a pressure differential of 1 psi. Size butterfly valves using the 90 degree flow coefficient (Cv).
 - 2) Modulating: Select valves with an appropriate flow coefficient (Cv) to achieve a minimum design valve authority of 0.5 relative to the total pressure drop of the piping branch the valve controls. Calculate Cv based on the larger of the following:

- a) 5-psig pressure drop at the design flow rate specified in the Schedules.
 - b) Twice the equipment design pressure drop as specified in the Schedules unless otherwise noted:
 - c) Valve shall not be less than 1/2 Inch in size.
 - d) Size butterfly valves using the 60 degree of full open flow coefficient (Cv).
- 4. Flow Characteristics:
 - a. Hydronic Service:
 - 1) Two-way valves: Equal percentage characteristic.
 - 2) Three-way valves: Linear characteristic.
 - 3) Chiller isolation valves: Linear characteristic.
 - b. Steam Service: Linear flow characteristics.
- 5. End Connections:
 - a. Reference the Control Valve Schedule in Part 3 for allowable end connections by pipe material.
 - b. Carbon steel and stainless steel valves shall comply with ASME B16.34.
 - c. Comply with ASME B16.10 for face-to-face and end-to-end dimensions.
 - d. Threads:
 - 1) Comply with ASME B1.20.1.
 - 2) Comply with ASME B16.4 for cast iron.
 - 3) Comply with ASME B16.15 for cast copper alloys, including bronze and brass.
 - e. Flanges:
 - 1) Comply with ASME B16.5 for steel.
 - 2) Comply with ASME B16.1 for cast iron
 - 3) Comply with ASME B16.24 for cast copper alloys, including bronze and brass.
 - f. Grooved Fittings:
 - 1) Water services to 230 deg F and 250 psig.
- B. Globe Pattern:
 - 1. Size: Reference the Control Valve Schedule in Part 3 for allowable valve size and end connection by application.
 - 2. Construction:
 - a. Up to 2 inches: Class 150, ASTM B62 bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
 - 1) Bronze body and bonnet shall conform to ASTM B62 up to pressure class 150. Conform to ASTM B61 for pressure class 200 and higher.
 - b. Over 2 Inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
 - 1) Iron body and bonnet shall conform to ASTM A126, class B.
 - c. Bonnet:
 - 1) Bronze body, Class 125: Threaded type.
 - 2) Bronze body, Class 150 or higher: Union type.
 - 3) Iron body: Bolted type.
 - d. Disc Material:
 - 1) PTFE.
 - 2) Stainless steel.

- e. Stem: Outside screw and yoke. Include extension for insulation.
 - f. Two-piece brass packing gland assembly, non-asbestos composition packing.
 - 3. Rangeability: Minimum 50:1.
 - 4. Leakage:
 - a. Up to 1-1/4 Inch: Minimum ANSI Class III per ANSI/FCI 70-2.
 - b. 1-1/2 Inch and Larger: Minimum ANSI Class IV per ANSI/FCI 70-2.
 - 5. Design and Testing:
 - a. MSS SP-80 for bronze.
 - b. MSS SP-85 for cast iron.
- C. Ball Pattern:
 - 1. Size: Reference the Control Valve Schedule in Part 3 for allowable valve size by application.
 - 2. Construction:
 - a. Body:
 - 1) Bronze conforming to ASTM B61, B62, and B584.
 - 2) Forged brass with or without nickel plating conforming to ASTM B283.
 - 3) Cast carbon conforming to ASTM A216.
 - 4) Cast iron according to ASTM A126.
 - 5) Stainless steel conforming to ASTM A351.
 - b. Up to 2 inches: Two-piece construction
 - c. Stainless steel, blowout proof stem. Include extension for insulation.
 - d. Replaceable PTFE seats and EPDM O-ring or PTFE packing seals.
 - 3. Ball: Full port with characterized insert comprised of the following material:
 - a. Stainless steel.
 - 4. Rangeability: Minimum 50:1.
 - 5. Leakage: Minimum ANSI Class IV per ANSI/FCI 70-2.
 - 6. Design and Testing:
 - a. MSS SP-72 for flanged ends.
 - b. MSS SP-110 for threaded and grooved ends.
- D. Butterfly Pattern:
 - 1. Size: Reference the Control Valve Schedule in Part 3 for allowable valve size by application.
 - 2. Construction:
 - a. Body: Lug ends suitable for connecting to ASME B16.5 flanges, or grooved ends.
 - 1) Cast iron according to ASTM A126.
 - 2) Ductile iron according to ASTM A536.
 - 3) Cast steel according to ASTM A216.
 - b. Disc:
 - 1) Aluminum bronze.
 - 2) Stainless steel.
 - 3) One-piece nylon coated ductile iron disc. Nylon coated discs are not allowed for open loop condenser water systems.
 - c. Stem: 416 Stainless steel. Include extension for insulation.
 - d. Replaceable PTFE or EPDM seats and seals.

3. Rangeability: Minimum 20:1.
 4. Leakage: Minimum ANSI Class IV, per ANSI/FCI 70-2.
 5. Design and Testing: MSS SP-67 for Class 150 and MSS SP-68 for pressure classes above 150.
- E. Manufacturers:
1. Belimo.
 2. Bray.
 3. Danfoss.
 4. Fisher Controls.
 5. Griswold Controls.
 6. Honeywell.
 7. Johnson Controls, Inc.
 8. Kele.
 9. Schneider Electric.
 10. Siemens.
 11. Victaulic (Tour & Andersson).

2.03 CONTROL DAMPERS

- A. Dampers shall be factory fabricated and sized as shown on drawings and as specified.
- B. Individual damper sections shall not be larger than 48 inches x 60 inches. Provide a minimum of one damper actuator per section.
- C. Performance: Test in accordance with AMCA 500-D.
1. Pressure Drop: Unless otherwise scheduled or indicated on the Drawings, size control dampers as follows:
 - a. Modulating Dampers: Provide dampers with linear flow characteristics. Size modulating dampers based on the smaller of the following.
 - 1) Maximum velocity of 1,500 feet per minute.
 - 2) Maximum Full-open air pressure drop of 0.1 inches W.C.
 - b. Two Position Dampers: Dampers shall be full duct size and selected to minimize pressure drop.
 2. Leakage:
 - a. Motorized dampers for outdoor, exhaust and relief air and for shaft and stairway vents shall be Class I leakage and shall not exceed 4.0 CFM/square foot in full closed position at 1 inch W.G. pressure differential across damper.
 - b. Motorized dampers for other applications shall be Class II leakage.
 - c. Fire/smoke dampers shall have fire resistance of 1-1/2 or 3 hours in accordance with UL 555 as required for the rated assembly that damper is installed.
 - 1) Fire/smoke damper shall have elevated temperature rating of [250 F][350 F] to remain open during smoke control operation.
 - d. Fire/smoke and smoke dampers shall be rated for Leakage Class I in accordance with UL555S and shall be rated for dual direction airflow.
- D. Frames: Galvanized steel, extruded aluminum, or stainless steel, welded or riveted with corner reinforcement.
1. Use minimum 16 gauge for rectangular dampers.
 2. Use minimum 20 gauge for round dampers.
 3. For aluminum frames, use 1/8 inch thick material.
 4. All damper frames shall have a flange for duct mounting.

5. Reference Part 3 Execution for application of the material type.
- E. Blades: Galvanized steel, extruded aluminum, or stainless steel, maximum blade size 6 inches wide, 48 inches long, attached to minimum 1/2 inch shafts with set screws.
 1. Use minimum 16 gauge for rectangular dampers.
 2. Use minimum 16 gauge for round dampers.
 3. For aluminum blades, use 1/8 inch thick material.
 4. The blades shall be suitable for the air velocities to be encountered in the system.
 5. Dampers longer than the maximum blade length shall be fabricated in sections.
 6. Reference Part 3 Execution for application of the material type.
- F. Blade Seals: Synthetic elastomeric inflatable or Neoprene, mechanically attached, field replaceable.
 1. Installed along the top and bottom of the frame and on all mating surfaces.
- G. Jamb Seals: Spring stainless steel.
 1. Installed inside the frame sides.
- H. Shaft Bearings: One of the following as recommended by manufacturer for the application:
 1. Oil impregnated sintered bronze.
 2. Graphite impregnated nylon sleeve with thrust washers at bearings.
 3. Lubricant free, stainless steel, single row, ground, flanged, radial, antifriction type with extended inner race.
 4. Molded synthetic bearings.
- I. Linkage Bearings: One of the following as recommended by manufacturer for the application:
 1. Oil impregnated sintered bronze
 2. Graphite impregnated nylon.
- J. Maximum Pressure Differential: 6 inches wg.
- K. Temperature Limits: -40 to 200 degrees F.
- L. Manufacturers:
 1. Greenheck.
 2. CESCO.
 3. Pottorff.
 4. Nailor.
 5. Ruskin.
- M. Reference the Damper Schedule in Part 3 for basis of design damper model and material for the application.
- N. Extended Warranty: Control dampers utilized in an economizer assembly shall be covered with minimum 5 year manufacturer warranty, certified to operate through 60,000 damper opening and closing cycles, and certified to meet leakage requirements specified above.

2.04 OPERATORS

- A. General:
 1. Voltage: Voltage selection shall be as required to achieve the required torque for the application.
 - a. Reference Part 3 for Damper Operator Voltage Schedule.
 2. Type: Motor operated, with or without gears. Motor type shall be continuous duty.
 3. Construction:
 - a. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.

- b. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.
 - c. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.
- 4. Field Adjustment:
 - a. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
 - b. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.
- 5. Two-Position Actuators: Single direction, spring return or reversing type. End-switches shall be integral to the actuator to determine actuator status.
- 6. Modulating Actuators:
 - a. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
 - b. Control Input Signal:
 - 1) Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.
 - 2) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10-Vdc or 2- to 10-Vdc and 4- to 20-mA signals.
 - 3) Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.
 - c. Programmable Multi-Function:
 - 1) Control Input, Position Feedback, and Running Time: Factory or field programmable.
 - 2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
 - 3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.
- 7. Position Feedback:
 - a. Where indicated on the controls drawings, equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
 - b. Where indicated on the controls drawings, equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
 - c. Actuator shall contain position indicator and graduated scale indicating open and closed travel limits.
- 8. Integral Overload Protection:
 - a. Provide against overload throughout the entire operating range in both directions.
 - b. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.
- 9. Attachment:
 - a. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to device without the need for connecting linkages.
 - b. Attach actuator to device drive shaft in a way that ensures maximum transfer of power and torque without slippage.

10. Temperature and Humidity:
 - a. Temperature: Suitable for operating temperature range encountered by application.
 - b. Humidity: Suitable for humidity range encountered by application, non-condensing.
 11. Enclosure:
 - a. Suitable for ambient conditions encountered by application.
 - b. NEMA 4 for indoor wash-down or wet locations.
 - c. NEMA 4X, Belimo ZS-300, or equivalent; for outdoor applications.
 - d. Provide actuator enclosure with heater and control where required by application.
 12. Stroke Time:
 - a. Coordinate with stroke time indicated on the control drawings.
 - b. Unless otherwise noted, select operating speed to be compatible with equipment and system operation.
- B. Damper Operators:
1. Controls contractor shall size damper operator.
 2. Sizing: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
 - a. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
 - b. Provide one operator for maximum 20 sq ft damper section or maximum 7 in-lb/sq ft damper area.
 3. Fail Positions:
 - a. Spring return to normal position as indicated on freeze, fire, temperature, or loss of power protection. Normal positions are indicated on the control drawings.
 - 1) Return air damper, normally open.
 - 2) Outside air damper, normally closed.
 - 3) Exhaust/Relief air damper, normally closed.
 - b. Operator shall fail in place for all other applications not listed under spring return.
- C. Valve Operators
1. Sizing: Select operator with sufficient torque capacity to operate the valve under all conditions and to guarantee tight shut-off of as specified against system pressure encountered.
 - a. Operators for Hydronic Control Valves: Capable of closing valve against system pump dead head.
 2. Fail Positions:
 - a. Spring return to normal position as indicated on freeze, fire, temperature, or loss of power protection.
 - 1) Pre-heat coil, normally open.
 - 2) Humidifier, normally closed.
 - 3) Other devices needing fail safe operation to account for freeze protection, power failure, overheating or moisture damage, reference control drawing points list for normal position.
 - b. Operator shall fail in place for all other applications not listed under spring return.
- D. Manufacturers:
1. Damper Operators:
 - a. Belimo.

- b. Honeywell.
- c. Johnson Controls.
- d. Schneider Electric (Invensys).
- e. Siemens.
- 2. Valve Operators:
 - a. Belimo.
 - b. Bray.
 - c. Danfoss.
 - d. Fisher Controls.
 - e. Honeywell.
 - f. Johnson Controls.
 - g. Schneider Electric (Invensys).
 - h. Siemens.

2.05 FLOW MEASURING APPARATUS

- A. Airflow Measuring Stations
 - 1. Sensor quantity and spacing shall comply with the Equal-Area or Log-Tchebycheff method as defined in the ASHRAE Handbook of Fundamentals.
 - 2. Element Construction: Non-corrosive material such as stainless steel, aluminum, or cadmium-plated.
 - 3. Stations and insertion elements utilizing thermal dispersion technology shall utilize hermetically sealed thermistors for each sensor and shall be factory calibrated to NIST traceable standards.
 - 4. Stations and insertion elements using velocity pressure shall be tested and certified in accordance with AMCA 611.
 - 5. Air Inlet Measuring Stations:
 - a. Intended for location within an air inlet to equipment, such as a hood or louver.
 - b. Elements:
 - 1) Element constructed of 316 stainless steel, factory mounted in a circular puck constructed of 14 gauge galvanized steel. Housing shall meet NEMA 1.
 - 2) Element shall not induce a measurable pressure drop, adversely affect fan performance or amplify the sound level within the fan system by its presence in the airstream.
 - 3) Element shall not be affected by the presence of moisture, dirt, or debris in the airstream and shall be unaffected by gusting wind.
 - 4) Density corrected for ambient temperature variances and atmospheric pressure due to altitude.
 - c. Range: Minimum 100 to 2,400 fpm.
 - d. Accuracy: Plus/minus 5.0 percent of reading within the calibrated airflow range.
 - e. Manufacturers:
 - 1) Air Monitor Corporation.
 - 2) Approved equal.
 - 6. Fan Inlet Air Flow Measuring Stations:
 - a. Located in the fan cone inlet with a minimum of two sensing elements.
 - b. Traverse Type Elements:

- 1) The elements shall not induce a measurable pressure drop, adversely affect fan performance or amplify the sound level within the fan system by its presence in the airstream.
- c. Surface Mount Probes:
 - 1) Velocity Pressure Type: The piezometer ring probes shall monitor the pressure difference between the largest and smallest diameters of the inlet cone venturi. High and low pressure sensors shall be connected to flow tubes extending to a termination plate mounted on the fan housing.
- d. Range: Minimum 100 to 10,000 fpm.
- e. Accuracy: Plus/minus 3.0 percent of the measured airflow range.
- f. Manufacturers:
 - 1) Air Monitor Corporation.
 - 2) Paragon Controls.
- 7. Duct Air Flow Measuring Stations
 - a. Located in a configuration and size equal to that of the duct it is installed.
 - b. The airflow traverse probe shall not induce a measurable pressure drop, nor amplify the sound level within the duct by its presence in the airstream.
 - c. Flow Straightener: Provide flow straightener as required by manufacturer of construction as needed to meet the application.
 - d. Range: Minimum 400 to 4,000 fpm.
 - e. Accuracy: Plus/minus 2.0 percent of the measured airflow.
 - f. Manufacturers:
 - 1) Paragon Controls.
- 8. Signal Processor:
 - a. Microprocessor-based, field programmable, capable of local display of the measured airflow rate.
 - b. Factory calibrated to NIST traceable standards.
 - c. Accuracy: 0.1 percent of full scale, including linearity, hysteresis, dead band, and repeatability.
 - d. Output: 0 to 10 Vdc or 4-20 mA scaled output signal for remote monitoring.
- B. Water Flow Meter: Provide Water Flow Meter as specified in Division 23 Section, "Meters and Gauges for HVAC Piping."
- C. BTU Meter: Provide BTU Meter as specified in Division 23 Section, "Meters and Gauges for HVAC Piping."
- D. Gas Flow Meter: Furnish gas flow meter as specified in Division 23 Section, "Meters and Gauges for HVAC Piping."

2.06 HUMIDISTATS

- A. Room Humidistats:
 - 1. Performance Characteristics:
 - a. Throttling range: Adjustable 2 percent relative humidity.
 - b. Accuracy: Plus/minus 3 percent over the operating range.
 - 1) Accuracy shall include temperature effects.
 - c. Operating range: 20 to 80 percent.
 - d. Drift: Less than 1 percent per year.
 - 2. Construction:
 - a. Wall-mounted enclosure: Plastic, NEMA 250, Type 1.

- b. Cover: Set point indication.
- 3. Output: Linear, proportional type over shielded cable pair, 4 - 20 mA or 0 – 10 Vdc signal..
- B. Limit Duct Humidistat:
 - 1. Insertion, two position switch type.
 - 2. Performance Characteristics:
 - a. Throttling range: Adjustable 2 percent relative humidity.
 - b. Accuracy: Plus/minus 5 percent over the operating range.
 - 1) Accuracy shall include temperature effects.
 - c. Operating range:
 - 1) High Limit Type: Minimum 50 to 95 percent.
 - d. Drift: Less than 1 percent per year.
 - 3. Construction:
 - a. Enclosure: Metal, NEMA 250, Type 1.

2.07 INPUT/OUTPUT SENSORS AND TRANSMITTERS

- A. General:
 - 1. Performance Requirements:
 - a. Device must be compatible with project DDC controllers.
 - b. Elements used shall be general-purpose type.
 - c. Provide transmitters or transducers with sensors as required, with range suitable for the system encountered.
 - 1) Transmitters and transducers shall have offset and span adjustments.
 - 2) Shock and vibration shall not harm the transmitter or transducer.
 - 3) Transmitters and transducers shall have a zeroing capability of readjusting the transmitter zero.
 - d. Accuracy requirements shall include the combined effects of linearity, hysteresis, repeatability, and the transmitter.
 - 2. Output: Linear, proportional type over shielded cable pair, 4 - 20 mA or 0 – 10 Vdc signal.
 - 3. Input Power: Low voltage, nominal 24 Vdc.
- B. Temperature Sensors:
 - 1. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy. Sensor shall be UL 873 listed for temperature equipment.
 - 2. Performance Requirements:
 - a. Thermistor:
 - 1) Accuracy (All): Plus/minus 0.36 degrees F minimum.
 - 2) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.
 - 3) Resolution: Plus/minus 0.2 degrees F minimum.
 - 4) Heat Dissipation Constant: 2.7 mW per degree C.
 - 5) Drift: 0.04 degree F after 10 years within temperature range.
 - b. RTD:
 - 1) Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F. 100 ohm platinum RTD is acceptable if used with project DDC controllers.
 - 2) Accuracy (All): Plus/minus 1 degree F minimum, unless otherwise noted below.
 - a) Room Sensor Accuracy: Plus/minus 0.5 degrees F minimum.

- b) Chilled Water Accuracy: Plus/minus 0.5 degrees F minimum.
 - c) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.
 - 3) Resolution: Plus/minus 0.2 degree F.
 - 4) Drift: 0.04 degrees F after 10 years within temperature range.
 - c. Sensing Range:
 - 1) Provide limited range sensors if required to sense the range expected for a respective point.
 - 2) Use RTD type sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.
 - d. Wire Resistance:
 - 1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.
 - 2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.
- 3. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
- 4. Room Temperature Sensors:
 - a. Construct for surface or wall box, or enclosure with insulated backing suitable for exterior wall mounting.
 - b. Provide the following features:
 - 1) Non-adjustable, blank front panel.
 - 2) Integral digital display with the following:
 - a) Indication of space temperature.
 - b) Setpoint adjustment to accommodate room setpoint.
- 5. Temperature Averaging Elements:
 - a. Use on duct sensors for ductwork 10 sq ft or larger.
 - b. Use averaging elements where prone to stratification with sensor length range between 16-22 ft.
 - c. Provide for all mixed air and heating coil discharge sensors regardless of duct size.
- 6. Insertion Elements:
 - a. Use in ducts not affected by temperature stratification or smaller than 10 sq ft.
 - b. Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches for pipe sizes greater than 4 inches.
 - c. Immersion Well Housing: 1/2 inch NPT brass or stainless steel. Stainless steel required for piping 6 inch and larger.
- C. Humidity Sensors:
 - 1. Elements: Accurate within 3 percent full range with linear output.
 - a. Accuracy shall include temperature effects.
 - 2. Resolution: Plus/minus 1 percent.
 - 3. Drift: Less than 1 percent full scale per year.
 - 4. Sensing Range: 0 to 100 percent relative humidity.
 - 5. Room Sensors: Provide housing with integral sensor. Housing shall be plastic, NEMA 250, Type 1. Provide with insulated backing suitable for exterior wall mounting.
 - a. Cover: Provide display indicating sensed humidity value.
 - 6. Duct Sensors: Insertion type probe with mounting plate. Housing shall be metal, NEMA 250, Type 1.

7. Outside Air Sensors: With element guard and mounting plate.
- D. Pressure Transmitters:
 1. Duct Static Pressure:
 - a. Type: Unidirectional, fixed range.
 - b. Performance Characteristics:
 - 1) Accuracy: Plus/minus one percent of full scale.
 - 2) Thermal Effects: Temperature compensated over a minimum 40 to 120 F range. Zero and span shift of plus/minus 0.06 percent or less of full scale per degree F.
 - 3) Sensing Range: Select sensor so that the high end of the nominal sensor range is not less than 150 percent and not more than 300 percent of maximum expected input.
 - 4) Long Term Thermal Stability: Plus/minus one percent full scale per year.
 - c. Construction:
 - 1) Insertion or traverse type sensor suitable for use in flat oval, rectangular, and round duct configurations.
 - 2) Insertion length selected as appropriate for duct size.
 - 3) Traverse sensors shall have at least one pickup point every 6 inches.
 - 4) Element: Variable capacitance sensing technology.
 - 5) Housing: Fire retardant glass-filled polyester, brass, stainless steel, or aluminum.
 2. Space Static Pressure:
 - a. Type: Bi-directional, fixed range.
 - b. Performance Characteristics:
 - 1) Accuracy: Plus/minus 0.5 percent of full scale.
 - 2) Thermal Effects: Temperature compensated over a minimum 40 to 120 F range. Zero and span shift of plus/minus 0.06 percent or less of full scale per degree F.
 - 3) Sensing Range: Select sensor so that the high end of the nominal sensor range is not less than 150 percent and not more than 300 percent of maximum expected input.
 - 4) Long Term Thermal Stability: Plus/minus 0.5 percent full scale per year.
 - c. Construction:
 - 1) Sensing Port Wall Mounting: Wall plate with integral sensor, sized to fit standard single gang electrical box. Back of sensor plate fitted with union fitting for tubing connection.
 - 2) Sensing Port Ceiling Mounting: Round plate with union fitting for tubing connection.
 - 3) Sensor Element: Variable capacitance sensor technology.
 - 4) Sensor Housing: Fire retardant glass-filled polyester, brass, stainless steel, or aluminum.
 3. Hydronic Pressure:
 - a. Type: Unidirectional, fixed range.
 - b. General Sensor Performance Characteristics:
 - 1) Accuracy: Plus/minus 1.0 percent of full scale.
 - 2) Thermal Effects: Temperature compensated minimum 30 to 150 F range. Zero and span shift of plus/minus 0.02 percent or less of full scale per degree F
 - 3) Long Term Thermal Stability: Plus/minus 0.5 percent full scale per year.

- 4) Range: Select sensor so that the scheduled differential pressure setpoint is near the midrange of the sensor pressure range.
 - c. Performance Characteristics for Chiller/Boiler Equipment Differential Pressure:
 - 1) Application: Variable-Primary Flow Systems.
 - 2) Accuracy: Plus/minus 0.05 percent of full scale.
 - 3) Thermal Effects: Temperature compensated minimum 30 to 150 F range. Zero and span shift of plus/minus 0.02 percent or less of full scale per degree F.
 - 4) Long Term Thermal Stability: Plus/minus 0.125 percent full scale per year for minimum 5 years.
 - 5) Range: Select sensor so that the scheduled differential pressure setpoint is near the midrange of the sensor pressure range.
 - 6) Manufacturers:
 - a) Rosemount, 3051S
 - b) Approved equal.
 - d. Construction:
 - 1) Suitable for the media temperature and pressure.
 - 2) Chiller/Boiler differential sensor shall have push button zero and span adjustments. No internal mechanical linkages shall be used in the transmitter.
 - 3) Element: Diaphragm type, stainless steel.
 - 4) Housing: Fire retardant glass-filled polyester, stainless steel, or aluminum.
- E. Equipment Operation Sensors:
- 1. Status Inputs for Airside Equipment:
 - a. Type: Fixed range differential pressure switch with adjustable setpoint.
 - b. Performance Characteristics:
 - 1) Range: Not greater than two times the design fan static pressure.
 - c. Construction:
 - 1) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered.
 - 2) Provide Insertion tube for use in duct configurations. Insertion length selected as appropriate for duct size.
 - 3) Contact Type: Single-pole, single-throw (SPST). Provide multiple poles or throw contacts to meet additional alarms required.
 - 2. Status Inputs for Hydronic Equipment:
 - a. Differential Pressure Switch: Fixed range type with adjustable setpoint.
 - 1) Range: Not greater than two times the design equipment differential pressure.
 - 2) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered.
 - 3) Contact Type: Single-pole, single-throw (SPST). Provide double-throw contacts to meet additional alarms required.
 - b. Flow Switch:
 - 1) Thermal dispersion flow switch enclosed in insertion device, of material suitable for fluid encountered and magnetic setpoint coordinated with the desired flow rate.
 - a) Range: Sensitivity suitable for the maximum and minimum design flow rates of the system in which it is installed.

- b) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered, with LED status indicators for visual switch indication.
 - c) Contact Type: Automatic reset upon regain of flow.
 - 3. Status Inputs for Electric Motors:
 - a. Binary Current Sensing Relay:
 - 1) Type: Split core with current transformers, adjustable and set to 175 percent of rated motor current.
 - 2) Self-powered with solid-state circuitry and a dry contact output.
 - 3) Adjustable trip point.
 - 4) Contact Type: Single-pole, double-throw (SPDT).
 - 5) LED indicating the on or off status.
 - 6) A conductor of the load shall be passed through the window of the device.
 - 7) Device shall accept overcurrent up to twice its trip into range.
 - F. Leak Detection Sensors
 - 1. Leak detection sensors shall be stand alone as described in Division 23 Section, Common Work Results for HVAC". Monitor leak detection sensors as noted on the drawings.

2.08 OUTPUT CONTROL DEVICES

- A. Control Relays:
 - 1. Provide relay with contact rating, configuration, and coil voltage that is suitable for the application.
 - 2. Provide NEMA 1 enclosure when relay is not installed in a local control panel.
 - 3. Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator.
 - 4. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus/minus 200 percent minimum from setpoint.
- B. Fan Speed Controllers:
 - 1. Solid-state model providing field-adjustable proportional control of motor speed. Equip with filtered circuit to eliminate radio interference.

2.09 POWER SUPPLIES

- A. Reference Division 23 Section "Direct Digital Controls for HVAC" for DC power supply requirements.
- B. Control power transformers shall meet NEMA/ANSI standards.
- C. Control power transformers shall be UL listed for Class 2 current-limited service or provided with over-current protection on both primary and secondary circuits for Class 2 current-limited service.
- D. Connected load on the transformer shall not exceed 80 percent of the transformer's rated capacity.
- E. The core and windings shall be completely encased in a UL approved thermoplastic. No metal parts shall be exposed other than the terminals.
- F. Performance Characteristics:
 - 1. Accuracy: Plus/minus 1 percent at 5.0 A full scale output.
- G. Provide a disconnect switch for each transformer.

2.10 ROOM PRESSURE CONTROLLER

- A. Type: Room pressure control system with control panel and integral differential pressure sensor.
- B. Features:

1. Backlit LCD screen which displays the following:
 - a. Room pressure.
 - b. Room status.
 - c. Indicator lights for normal and alarm.
 2. Touch-screen or button interface.
 3. Visual and audible alarms.
 - a. Include time delays for nuisance alarm reduction.
 4. Alarm relay contacts.
 5. Building automation system communication interface.
 6. Provide with analog input from temperature and humidity sensor
 7. Provide binary input from door switch and motion sensor.
- C. Performance Requirements:
1. Pressure sensor:
 - a. Accuracy: Plus/minus 10 percent of reading or plus/minus 0.25 percent of full scale.
 - b. Resolution: Plus/minus 5 percent of reading, to the nearest 0.0001 inch W.C.
 - c. Long Term Stability: Plus/minus 1 percent full scale per year.
 - d. Range:
 - 1) Sensing: Minus 0.2 to 0.2 inches W.G.
 - 2) Minimum Compensated Temperature Range: 55 to 95 degrees F.
 - 3) Minimum Operating Humidity: 5 to 95 percent relative humidity.
 2. Operation: The system shall alarm via audible and visual means upon loss of pressure relationship.
- D. Construction:
1. Enclosure: Fire retardant plastic, UL 94 rated for V-0.
- E. Manufacturers:
1. Accutrol
 2. TSI Pressura.
 3. Siemens.
 4. setra.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.02 EXISTING EQUIPMENT

- A. Pneumatic Equipment: Where equipment is allowed to be reused for project scope as indicated on the drawings, verify the integrity and proper operation of equipment prior to reuse.
- B. Wiring: The contractor may reuse any abandoned wires. The integrity of the wire and its proper applications to the installation are the responsibility of the contractor. The wire shall be properly

identified and tested. Unused or redundant wiring that remains in place shall be identified as such.

- C. Local Control Panels: The contractor may reuse any existing local control panels to locate new equipment. All redundant equipment within these panels shall be removed. Panel face cover shall be patched to fill all holes caused by removal of unused equipment or replaced with new.
- D. Repair: Unless otherwise directed, the contractor is not responsible for repair or replacement of existing energy equipment and systems, valves, dampers, or actuators. Should the contractor find existing equipment that requires maintenance, notify the engineer immediately.
- E. Temperature sensor wells: The contractor may reuse any existing wells in piping for temperature sensors. The wells shall be modified as required for proper fit of new sensors.
- F. Indicator Gauges: Where these devices remain and are not removed, recalibrate and ensure reasonable accuracy.
- G. Unless otherwise noted, salvage, recondition, and reuse the following devices:
 - 1. Room thermostats.
 - 2. Electronic sensors and transmitters.
 - 3. Controller and auxiliary electronic devices.
 - 4. Damper actuators, linkages, and appurtenances.
 - 5. Control valves.
- H. Patch holes and finish to match existing walls.

3.03 INSTALLATION

- A. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.
- B. Coordinate with other contractors performing work to provide emergency power to all control devices required to operate on emergency power.
 - 1. Coordinate emergency power to BAS network control panels.
 - 2. Coordinate power wiring for smoke control equipment is installed in metallic conduit.
- C. General Workmanship:
 - 1. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.
 - 2. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
 - 3. Install all equipment in readily accessible locations.
 - 4. All installations shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
 - 5. Install all products in accordance with manufacturer's instructions.
- D. Sensors:
 - 1. Mount sensors rigidly and adequately for the environment within which the sensor operates.
 - 2. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing. Coordinate installation of room/space sensors with architect and other trades to ensure a neat and orderly installation.
 - 3. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
 - 4. Sensors used in mixing plenums and hot and cold decks shall be of averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

5. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1 foot of sensing element for each square foot of coil area.
6. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 10 feet downstream.
7. Install temperature, humidity, and smoke detectors for both supply air and return air applications a minimum of 10'-0" downstream or upstream of the air handling unit and prior to any branch duct takeoffs.
8. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
9. Install outdoor air temperature sensors on north wall, complete with sun shield where shown on the plans. If not shown, locate sensors in an accessible location, a minimum of 15 feet away from exhaust or relief air locations.
10. Differential air static pressure.
 - a. Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
 - b. Return Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor or the plenum.
 - c. Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building. Pipe the high-pressure port to a location suitable to sense common building pressure or as indicated on the drawings.
 - 1) Panel mount the transducer adjacent to its associated building automation system controller. Provide an independent manometer gauge next to transducer for calibration.
 - d. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
 - e. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
 - f. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.
11. Adjust flow switch to meet sensitivity required to ensure minimum flow through the equipment.
12. Check and verify location of thermostats, humidistats, and exposed control sensors with plans and room details before installation. Locate 48 inches above floor. Align with adjacent lighting switches and humidistats.
 - a. Install devices to meet ADA requirements unless otherwise noted on the plans.
13. Mount freeze protection thermostats using flanges and element holders.
 - a. Install thermostat completely across the surface the thermostat serves.
14. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
15. Provide separable sockets for liquids and flanges for air bulb elements.
16. Provide thermostats in aspirating boxes in areas where flush mounting is required.
17. Provide guards on thermostats in areas indicated on the drawings.

18. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
 19. Install shutoff valves in the high and low pressure reference lines connecting to hydronic pressure sensors and switches. Install a shunt valve across the high and low reference pressure ports for servicing. Valves may be ordered as an integral option with the sensor.
- E. Control Valves:
1. Do not install brass valves in open-loop systems.
 2. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.
 3. Install flanges or unions to allow valve removal and installation.
 4. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
 5. Valve Orientation:
 - a. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
 - b. Install valves in a position to allow full stem movement.
 - c. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.
 6. Provide valves with position indicators where sequenced with other controls.
 7. Tag valves in accordance with Division 23 Section, "Identification for HVAC Piping and Equipment."
 8. Install a pressure/temperature port on each side of pressure independent control valves (PICVs) which are not factory provided with integral ports.
- F. Control Dampers:
1. Install dampers with extruded aluminum or stainless steel frames and blades in corrosive environments and areas with high humidity.
 2. Install smooth transitions, not exceeding 30 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.
 3. Clearance:
 - a. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
 - b. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.
 4. Service Access:
 - a. Dampers and actuators shall be accessible for visual inspection and service.
 - b. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Division 23 Section, "Air Duct Accessories."
 5. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting.
 6. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
 7. Provide mixing dampers of parallel blade construction arranged to mix streams. Where shown on the drawings, provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.

8. Provide isolation (two position) dampers of parallel blade construction.
 9. Provide opposed blade damper configuration for all other applications.
 10. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
 11. After installation of low-leakage dampers and seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.
- G. Operators:
1. Mount and link control damper actuators according to manufacturer's instructions.
 - a. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5 degrees open position, manually close the damper, and then tighten the linkage.
 - b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - c. Provide all mounting hardware and linkages for actuator installation.
 2. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degree available for tightening the damper seals.
 3. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer.
- H. Control Panels:
1. Install control panels where shown on the drawings and where required to house controllers for the controlled systems and equipment.
 2. 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 engraved plastic nameplates on cabinet face.
 3. Coordinate 120V power requirements with Division 26 to panels used for the building automation system and transformers for low voltage power to controllers.
- I. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- J. Provide an insulation standoff on control devices, cables, and other items that do not require flush mounting to ductwork, piping, or equipment.
- K. Install room pressure monitoring system per manufacturer installation instructions. Provide additional rough-in and tubing for accessories such as pressure snubbers and remote annunciators required to perform the system functions. Schedule manufacturer representative to provide start up, testing, and owner operating instructions to owner.

3.04 MAINTENANCE

- A. Refer to Division 01 closeout requirements for additional requirements relating to maintenance service.
- B. Provide service and maintenance of control system for one year from Date of Substantial Completion.
- C. Provide complete service of controls systems, including call backs, and submit written report of each service call.

3.05 STARTUP AND DEMONSTRATION

- A. Control Dampers and Valves:
 1. Stroke and adjust control valves and dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.
 2. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

3. For control valves and dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
4. Verify that all two-position dampers and valves operate properly and that the normal positions are correct.
5. Verify that all modulating dampers and valves are functional, that the start and span are correct, that direction and normal positions are correct, and that they achieve proper closure.

B. PI Control Valves:

1. Field verify installation and operating differential pressure range of all PI control valves.
2. Verify total system flow to be within plus/minus 10 percent of system design.
3. Verify correct individual performance for each valve as noted on the drawings.
4. Individual field adjustments for the PI control valve assembly shall be performed using the PI control valve manufacturer's documented procedures.

3.06 DAMPER SCHEDULE

<u>SERVICE</u>	<u>RUSKIN MODEL</u>	<u>MATERIAL</u>
Outside, Exhaust and Relief Air Control, Stairway and Shaft Vents	CD-50	Aluminum
Fire/Smoke Damper for Smoke Control	FSD-60	Galvanized Steel
Smoke Damper for Smoke Control	SD-60	Galvanized Steel
Corrosive Environments	CD-50-CE	Aluminum
Corrosive Environments	CD-36-CE	Stainless Steel
All Other	CD-356	Galvanized Steel

3.07 DAMPER OPERATOR VOLTAGE SCHEDULE

<u>SERVICE</u>	<u>VOLTAGE</u>
Interlocked with HVAC fans	120V
Multi-section dampers	120V
Large dampers (> 60 inches in any dimension)	120V
All other operators control wiring	24V

1. Note: Coordinate with Division 26 if 120V power is required for operator to achieve appropriate torque requirements for damper actuation.

3.08 CONTROL VALVE SCHEDULES

A. Allowable Valve Type and Size by Control Application:

<u>VALVE TYPE</u>	<u>MODULATING</u>	<u>TWO-POSITION</u>
Globe	≤ 4 IN	≤ 2 IN
Characterized Ball	≤ 2 IN	≤ 2 IN
Butterfly	> 2 1/2 IN	≥ 2-1/2 IN

B. Allowable Valve Body Material by Service Application:

<u>VALVE BODY MATERIAL</u>	<u>CLOSED LOOP</u>	<u>OPEN LOOP</u>
Bronze	Allowed	Allowed
Iron	Allowed	Allowed
Stainless Steel	Allowed	Allowed

C. Allowable End Connection by System Material:

1. Copper Tube:

- a. 2-1/2 Inch and smaller: Threaded ends.
- 2. Steel Pipe:
 - a. 2 Inch and Smaller: Threaded.
 - b. 2-1/2 Inch and Larger:
 - 1) Flanged.
 - 2) Grooved ends for water systems.

D. Allowable End Connection by Size Schedule:

VALVE TYPE	END CONNECTION TYPE		
	THREADED	FLANGED	GROOVED
Globe	≤ 2-1/2 IN	≤ 4 IN	N/A
Characterized Ball	≤ 2-1/2 IN	≤ 3 IN	N/A
Butterfly	N/A	≥ 2-1/2 IN	≥ 2-1/2 IN

END OF SECTION 23 09 13

SECTION 23 09 23 DIRECT-DIGITAL CONTROL FOR HVAC

PART 1 - GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

- A. System Description
- B. Operator Interface
- C. Controllers
- D. Electrical Control Power Wiring and Low Voltage Wiring
- E. Local Area Network
- F. System Software
- G. Controller Software

1.02 RELATED REQUIREMENTS

- A. Section 230010 – General Mechanical Requirements.
- B. Section 230800 – Commissioning HVACR Systems.
- C. Section 230913 - Instrumentation and Control Devices for HVAC.
- D. Section 275313 - Clock Systems.
- E. Section 281600 - Intrusion Detection.
- F. Section 281300 - Access Control.
- G. Section 283111 – Digital Addressable Fire Alarm Systems.

1.03 REFERENCE STANDARDS

- A. ANSI/CEA 709.1.D - Control Network Protocol Specification; 2014.
- B. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; most current edition.
- C. IEEE C37.90.1 – IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus, most current edition.
- D. IEEE C62.41.2 – IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits, most current edition.
- E. ISO 7498 – Information Processing Systems – Open System Interconnection – Basis Reference Model, International Standards Organization, most current edition.
- F. NEMA – National Electrical Manufacturers Association.
- G. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers. Optional attendees include the Commissioning Agent and the Owner, Architect, and Engineer.

1.05 DEFINITIONS

- A. ASC: Application Specific Controller. Examples include controllers for specific applications (e.g., FCU, VAV box, etc.) that can be configured through any network services software.
- B. ATU: Air Terminal Unit (e.g., VAV boxes, fan-powered boxes, fan coil units).
- C. BAS: Building Automation System.
- D. BTL: BACnet Testing Laboratories. Third party independent testing and listing program for devices which have been tested according to ASHRAE Standard 135.

- E. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and IP switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operations
- F. DDC: Direct Digital Control.
- G. EMT: Electrical Metallic Tubing
- H. High voltage: 50 volts or higher.
- I. IP: Internet Protocol.
- J. LAN: Local Area Network.
- K. VLAN: Virtual Local Area Network.
- L. Low voltage: Below 50 volts.
- M. OSI: Open System Interconnection
- N. PC: Personal Computer.
- O. PICS: Protocol Implementation Conformance Statement.
- P. Point: Point is a generic term used to describe a single item of information in a BAS. Points may be further described as input, output, digital, binary, discrete, analog, modulating, internal, external, virtual or global. Each unique point used by digital controllers, or in a BAS, is typically identified by an address.

1.06 CONTRACTOR RESPONSIBILITIES

- A. Reference sections 230015, 230800, and 230913 for contractor responsibilities and coordination.
- B. Reference Part 3 for additional electrical contractor responsibilities for BAS controls.

1.07 SUBMITTALS

- A. Refer to Division 01 and Section 230010 for submittal procedures.
- B. General:
 - 1. The drawings and specifications are not intended to show all details. The BAS contractor shall secure satisfactory information before submitting the proposal and include in the proposal a sum sufficient to cover all items of labor and material required for the complete installation for the devices and system described.
 - 2. Inform Engineer in writing of any deviation in the exhibits submitted from the requirements of the drawings, specifications, and sequences of operations.
- C. Product Data:
 - 1. Submit manufacturer technical data for each system component and software module required for a complete installation.
 - 2. Indicate dimensions, weights, and enclosure construction for all BAS distributed controllers.
 - 3. Submit technical data on all new software supplied including description of functions performed by software and location within the system where software shall reside. Include all software licensing agreements.
 - 4. Submit the PICS for each BACnet device used in the BAS.
- D. Power and Communication Wiring Transient Protection:
 - 1. Submit catalog data sheets providing evidence that all BAS products offered by the manufacturer are tested and comply with IEEE C62.41.2.
 - a. Testing shall include power and communication trunk wiring.
 - b. Compliance with IEEE C62.41.2 shall imply conformance with IEEE C37.90.1 based on the stated position of ANSI and IEEE.
- E. Shop Drawings:

1. Submit a riser diagram depicting locations of all controllers and workstations, with associated network wiring.
 - a. Indicate equipment served by each controller on the diagram.
 - b. Indicate switches, power requirements to each controller, and daisy chained controllers.
2. Submit detailed schematic control drawings for each controlled device and equipment.
 - a. Reference all control components to manufacturer make and model number.
 - b. Include all control and power wiring with termination point (controller and terminal number).
 - c. Include clearly indicated and written sequences of operation referenced to specific control components (e.g., "shall modulate valve V-3").
 - d. Include default position (e.g., N.O., N.C., etc.) for all components where applicable.
 - e. Clearly differentiate between existing components and new components.
 - f. Include detailed wiring diagrams showing methods of connections to VFDs, motor starters, energy meters, and all other devices, and all other field wiring necessary for system installation.
 - g. The use of "typicals" will be allowed where appropriate.
3. Submit detailed drawings for each individual BAS distributed controller.
 - a. Include controller identification.
 - b. Include components included in the controller.
 - c. Include numbering of terminals and communications ports.
 - d. List connected data points, including connected control unit and input device.
 - e. Include type of cable connected to each terminal port.
 - f. Identify specific field devices wired to each terminal including identification of each field device and application.
 - g. Clearly differentiate between existing controllers and new controllers.
 - h. Indicate source (electrical panel ID) of 120V power to each panel to which 120V power is connected.
 - i. Indicate method of connecting controller to equipment supplied by others and to existing communications networks.
4. Submit floor plans that indicate the following:
 - a. Location of all new BAS distributed controllers and control panels.
 - b. Routing of all new building level network communications wiring not located in mechanical and electrical rooms.
 - c. Routing of wiring to controllers, sensors, and control points not located in mechanical and electrical rooms.
 - d. Location of building system connection to Owner's campus wide data network.
5. Submit methods and materials used to connect existing communications network.
6. All control drawings and schematics shall be generated using AutoCAD software or equivalent. All project drawings shall be supplied to the Owner in a format as desired by the Owner upon project completion.
7. Submit system identification nomenclature.
 - a. Naming and numbering convention shall be consistent with the existing building BAS naming convention.
 - b. Point names and naming convention shall be consistent with point names shown on the drawings. The HCA standard naming convention shall be used where a conflict between the standards and name on the drawings occurs.

- c. Equipment tags shall be consistent with equipment tags shown on the drawings.
- 8. Indicate BAS graphics indicating monitored systems, data (connected and calculated) and operator notations.
 - a. Submit example graphic visualizations and screenshots for the BAS. At a minimum, submit examples for major HVAC equipment components, including chillers, boilers, air handling units, fan coil units, heat pumps, fans, etc.
 - b. Font size and type shall be manufacturer standard.
 - c. Provide graphics demonstration package in a format as desired by the Owner.
- F. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.
- G. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
 - 2. Include submittals data in final "Record Documents" form.
 - 3. All additions or changes to the BAS during the course of construction shall be reflected upon the drawings and submitted to the Engineer before project close-out.
- H. Testing and Commissioning Reports and Checklists: Submit completed versions of all reports and checklists, along with all trend logs, used to meet the requirements of Part 3, Startup and Demonstration.
- I. Operation and Maintenance Data:
 - 1. Include maintenance data and recommended spare parts list for digital control equipment and control components.
 - 2. Include trouble-shooting maintenance guides.
 - 3. Include interconnection wiring diagrams showing complete field installed systems with identified and numbered system components and devices.
 - 4. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 5. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - 6. Include a maintenance manual which contains the information listed above, product data, shop drawings, final software code for sequences of operation and maintenance data in accordance with requirements of Division 01.
 - 7. Include logbook for documentation of software updates and patches applied BAS for the time period included in the software licensing agreement.
 - 8. Provide names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
- J. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- K. Maintenance Materials:
 - 1. Refer to Division 01 for additional provisions.
 - 2. Extra Stock Materials: Two printer cartridges and cartons of printer paper.

1.08 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
- C. Design system software under direct supervision of a Professional Engineer experienced in design of this Work and licensed at the State in which the Project is located.

- D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- E. Installer Qualifications: Company specializing in performing the work of this section with minimum 10 years experience approved by manufacturer.
 - 1. All personnel of the BAS Contractor shall have a minimum of three years of experience within their appropriate trades.
 - 2. All subcontractors utilized by the BAS Contractor shall have a minimum of five years experience within their appropriate trades.

1.09 WARRANTY

- A. Refer to Division 01, for additional project warranty requirements.
- B. Labor and materials for the BAS specified shall be warranted free from defects in workmanship and material for a period of 1 year after Substantial Completion and system acceptance, as defined in Part 3.
- C. BAS failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner.
- D. All work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period.
- E. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
- F. Contractor shall maintain and provide a standard 12 month warranty for any existing equipment, wiring, and controllers that are selected to be reused for the project. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of system commissioning.
- G. Special warranty on instrumentation:
 - 1. All instrumentation shall be covered by manufacturer's transferable one-year "No Fault" warranty. If manufacturer warranty is not available, the BAS installer shall provide the same.

1.10 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
 - 1. Limiting use of software to equipment provided under these specifications.
 - 2. Limiting copying.
 - 3. Preserving confidentiality.
- B. Software provider shall provide software updates and patches to the BAS as part of the software licensing agreement as the updates and patches are released. If any security vulnerabilities are discovered by the provider, the provider shall notify the client within five business days.
- C. Ownership of Proprietary Material: Project-specific software and documentation shall become Owner's property upon project completion. This includes, but is not limited to the following:
 - 1. Graphics.
 - 2. Record drawings.
 - 3. Database.
 - 4. Application programming code.
 - 5. Documentation.

PART 2 - PRODUCTS

2.01 OWNER FURNISHED PRODUCTS

- A. New Products: Johnson Controls shall be used on all projects on which the existing BAS is a Johnson Control System and on all new construction in which the new building is not associated with an acute care hospital that has either a Siemens or Schneider Electric (or associated legacy brand, see below) installed
- B. Existing Products: The existing building is provided with an existing DDC front end.

2.02 MANUFACTURERS

- A. Acceptable Manufacturers: Johnson Controls (JCI) Metasys (Facility Explorer is not acceptable), Siemens Apogee, or Schneider Electric StruxureWare
- B. The above list of manufacturers applies to operator workstation software, controller software, the custom application programming language, building controllers, custom application controllers, and application specific controllers. All other products specified under Section 230913 need not be manufactured by the above manufacturers.

2.03 SYSTEM DESCRIPTION

- A. General:
 - 1. Furnish and install a complete BAS.
 - 2. The BAS shall consist of all necessary hardware and software to perform the control sequences of operation as called for in the Specifications and Drawings. Contractor shall install and commission all necessary devices to ensure a reliable and stable network.
 - a. BACnet devices used in the BAS shall be BTL listed according to its device profile.
 - 3. The BAS shall be capable of integrating multiple devices, sensors, and functions from multiple control vendors into a common front end, including equipment supervision and control, alarm management, energy management, and trend data collection.
 - 4. The BAS 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.
 - 5. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- B. Local Area Network:
 - 1. The BAS shall be set up using a VLAN connection into the Owner's internet or enterprise intranet.
 - a. The VLAN shall be digitally separate from all other networks and shall share a common physical cabling backbone.
 - b. Coordinate with the Owner to configure Ethernet and IP router switches to accommodate the VLAN.
 - 2. The BAS shall be connected to the facility LAN and shall permit an unlimited number of simultaneous users to access the system over the LAN, and to (based on password level) monitor parameters, change set points, set up trends, or start/stop controlled equipment.
 - a. A remote user shall have this capability without having the system database loaded on his/her remote computer.
 - b. Connection by remote Energy Management system shall be accommodated by allowing polling of BAS parameters over BACnet IP.
- C. Network Integration:

The BAS/DDC shall use BACnet/IP protocol capable of communicating over an Ethernet system. It shall be capable of residing on the HCA Enterprise WAN/LAN by having an assigned IP address. BAS/DDC systems are required to permit a remote user with password access, monitor points and issue basic commands over the HCA WAN/LAN using a PC type terminal without the need for proprietary BAS/DDC software. The system database shall reside on

an owner-furnished server, not a PC. The user interface is to be installed on an owner-furnished workstation. Controls contractor to coordinate and verify with HCA Corporate FacilitiGroup Energy Service Center full BAS communication between the facility and ESC.

1. Provide gateways or other integration devices across networks with different communication protocol to provide a single network visibility and interoperability at the operator workstation.
 - a. Coordinate communication protocol with each automation system specified.
 2. Interoperable networks shall be capable of sharing all point and point information across networks to a single BAS front end.
 3. Interoperable networks shall be capable of automatically downloading application program changes.
 4. For integrated networks that cannot automatically download application program changes, provide a "hot link" to hop between the existing networks to accomplish application program changes. Provide link to separate network at the BAS front end summary page.
- D. Critical System Requirements:
1. The BAS network shall contain redundancies related to its corresponding tier criticality as noted on the drawings:
 - a. Tier 1 = Redundant emergency generator power.
 - 1) Coordinate with Division 26 for emergency generator power size and power duration.
 2. All building level and field equipment controllers except for controllers on terminal units not serving critical spaces shall be provided with an uninterruptible power system (UPS) to allow for continuous operation of all equipment during loss of normal power until stand by power is achieved.
 - a. Size the UPS to operate for a minimum of 15 minutes.
 - b. Elements of the control system susceptible to power surges shall be protected by conditioners, suppressors or other approved means.
 - c. Coordinate the size of the UPS with Division 26.
 3. Requirements for Smoke Control Networks:
 - a. Network controllers and components used for smoke control operations shall be U.L. 864 – UUKL rated.
 - b. Control wiring used for smoke control operations shall be installed in metallic conduit.
 - c. Control system shall be capable of communicating with the building's fire alarm system to fulfill the sequences of operation specified in this section or on the drawings.
 - d. The BAS Contractor shall provide a Fire Fighter's Smoke Control Panel to manually control the smoke evacuation system. Reference Section 230913 for panel requirements.
- E. Network Architecture: The BAS network architecture shall be based upon the OSI basic reference model in accordance with ISO 7498.
1. Acceptable Protocol:
 - a. Application/Network Layer:
 - 1) BACnet protocol complying with ASHRAE Standard 135.
 - b. Physical/Data Link Layer:
 - 1) Hard-wired type:
 - a) Ethernet according to ISO 8802-2 protocol.
 - b) EIA-485 Twisted Cable Pair according to Master Slave/Token-Passing (MS/TP) protocol.
 - c) EIA-232 Cable according to Point-to-Point (PTP) protocol.

2.04 OPERATOR INTERFACE

A. General:

1. The Operator Interface shall provide overall BAS supervision and system software interface. Communications from the workstation shall be executed directly to and between the integration level building controllers and field level controllers.
2. The operator interface shall be capable of accessing all system data, independent of hardware technology.

B. PC Based Work Station:

1. Connected to server for full access to all system information.
2. Provide a PC for command entry, information management, network alarm management, and database management functions.

C. Hardware:

2.05 CONTROLLERS

A. Building Controllers

1. General:

- a. Input Power Requirements: 24Vac/dc.
- b. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
- c. Provide sufficient memory to support controller's operating system, database, and programming requirements.
- d. Share data between networked controllers.
- e. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
- f. UPS with 15 minutes backup for all building level and field equipment level controllers except controllers on terminal units not serving critical spaces
- g. Utilize real-time clock for scheduling.
- h. Continuously check processor status and memory circuits for abnormal operation.
- i. Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
- j. Communication with other network devices to be based on assigned protocol.
- k. Monitor the status of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited.

2. Communication:

- a. Perform routing when connected to a network of custom application and application specific controllers.
- b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 1) Port shall be USB type.

3. Anticipated Environmental Ambient Conditions:

- a. Conditioned Space:
 - 1) Mount within NEMA 1 dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.

4. Local Keypad and Display for each Controller:

- a. Use for interrogating and editing data.
- b. System security password prevents unauthorized use.

- c. If the manufacturer does not normally provide a keypad and display for the controller, provide software and interface cabling needed to use a portable operator terminal for the system.
- 5. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
- 6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
- 7. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention.
 - d. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- 8. Surge and Transient Protection:
 - a. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard C62.41.2.
 - b. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.
- B. Custom Application Controllers
 - 1. General:
 - a. Input Power Requirements: 24Vac/dc.
 - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - c. Share data between networked, microprocessor based controllers.
 - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - e. Utilize real-time clock for scheduling.
 - f. Continuously check processor status and memory circuits for abnormal operation.
 - g. Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - h. Communication with other network devices to be based on assigned protocol.
 - i. Monitor the status of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited.
 - j. UPS with 15 minutes backup for all building level and field equipment level controllers except controllers on terminal units not serving critical spaces
 - 2. Communication:
 - a. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 3. Anticipated Environmental Ambient Conditions:
 - a. Conditioned Space:
 - 1) Mount within NEMA 1 dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.

4. Local Keypad and Display for each Controller:
 - a. Use for interrogating and editing data.
 - b. System security password prevents unauthorized use.
 - c. If the manufacturer does not normally provide a keypad and display for the controller, provide software and interface cabling needed to use a portable operator terminal for the system.
5. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
7. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Upon restoration of normal power, the Digital Panel shall automatically resume full operation without manual intervention.
 - d. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
8. Surge and Transient Protection:
 - a. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard C62.41.2.
 - b. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.
- C. Application Specific Controllers
 1. General:
 - a. Input Power Requirements: 24Vac/dc.
 - b. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
 - c. Customized for operation within the confines of equipment served.
 - d. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - e. Communication with other network devices to be based on assigned protocol.
 - 1) Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
 - f. Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - g. UPS with 15 minutes backup for all building level and field equipment level controllers except controllers on terminal units not serving critical spaces
 2. Communication:
 - a. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 1) Port shall be USB type.
 - 2) The capabilities of the portable service terminal shall include, but not be limited to the following:
 - a) Display temperatures

- b) Display status
 - c) Display setpoints
 - d) Display control parameters
 - e) Override binary output control
 - f) Override analog setpoints
 - g) Modification of gain and offset constants
- 3. Anticipated Environmental Ambient Conditions:
 - a. Conditioned Space:
 - 1) Mount within NEMA 1 dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F and 95 percent RH, non-condensing.
- 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
- 5. Memory. The application specific controller shall use nonvolatile memory and maintain all BIOS and programming information in the event of a power loss.
- 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention.
 - d. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- 7. Surge and Transient Protection:
 - a. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard C62.41.2.
 - b. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.
- D. Input/Output Interface
 - 1. Hardwired inputs and outputs shall tie into the BAS through building, custom application, or application specific controllers.
 - 2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
 - c. Universal-type inputs or outputs configurable between binary and analog are acceptable.
 - 3. Binary Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.
 - b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
 - c. Sense dry contact closure with power provided only by the controller.
 - 4. Analog Inputs:

- a. Allow for monitoring of low voltage 0 to 10 Vdc, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
- 5. Binary Outputs:
 - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
 - b. Binary Outputs for Fire-Fighter Control Panel:
 - 1) Outputs provided with three position (On/Off/Auto) override switches.
 - 2) Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
- 6. Analog Outputs:
 - a. Monitoring signal provides a 0 to 10 Vdc or a 4 to 20 mA output signal for end device control.
 - b. Drift to not exceed 0.4 percent of range per year.
 - c. Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

2.06 ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING

- A. Power Wiring
 - 1. Copper wiring, plenum cable, and raceways shall be as specified in the applicable section of Division 26.
- B. Power and Communication Wiring Transient Protection:
 - 1. Comply with IEEE C62.41.2.
 - 2. Communications trunk wiring shall be protected with a transient surge protection device providing the minimal protection required.
 - 3. Communication circuitry, input/output circuitry, and communication unit shall provide protection against a 1000 volt, 3 amp transient signal, directly applied to the communication or input/output terminations.
 - a. For systems not complying with this requirement, provide equivalent protection external to the automatic temperature control system controller. Protection shall be provided for the individual communications and input/output terminations for each automatic temperature control system controller.
 - b. Submittal documentation shall clearly define how this requirement will be met and how the external protection will not affect the performance of the controllers.
- C. Power Supplies and Line Filtering:
 - 1. Power Supplies:
 - a. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
 - b. Limit connected loads to 80 percent of rated capacity.
 - c. Match DC power supply to current output and voltage requirements.
 - d. Power supplies shall be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
 - e. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
 - f. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
 - g. Operational Ambient Conditions: 32 to 120 degrees F.

- h. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration.
 - i. Line voltage units UL recognized and CSA approved.
 - 2. Power Line Filtering:
 - a. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
 - b. Minimum surge protection attributes:
 - 1) Dielectric strength of 1000 volts minimum.
 - 2) Response time of 10 nanoseconds or less.
 - 3) Transverse mode noise attenuation of 65 dB or greater.
 - 4) Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.
- D. Input/Output Control Wiring
 - 1. Control wiring shall be sized to accommodate the voltage drop associated with the distance between the control device and the controller. Minimum size shall be as specified herein.
 - 2. In all communication conduits, provide one spare twisted pair to be installed, tagged and labeled at each end.
 - 3. Control wiring not installed in conduit shall be UL rated for plenum installation.
 - 4. Ethernet control wiring shall be fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
 - 5. RTD wiring shall be three-wire or four-wire twisted, shielded, minimum number 22 gauge.
 - 6. Other analog inputs shall be a minimum of number 22 gauge, twisted, shielded.
 - 7. Binary control function wiring shall be a minimum of number 18 gauge.
 - 8. Analog output control functions shall be a minimum of number 22 gauge, twisted, shielded.
 - 9. Binary input wiring shall be a minimum of number 22 gauge, twisted, shielded.
 - 10. Thermistors shall be equipped with the manufacturer's calibrated lead wiring.
 - 11. 120V control wiring shall be #14 THHN in 3/4 inch conduit. Provide 20% fill extra wire in each conduit.
- E. Splices
 - 1. Splices in shielded cables shall consist of terminations and the use of shielded cable couplers that maintain the integrity of the shielding.
- F. Conduit and Fittings
 - 1. Conduit for Control Wiring, Control Cable and Transmission Cable: EMT with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.
 - 2. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.
 - 3. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.
 - 4. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.
- G. Relays
 - 1. Relays other than those associated with digital output cards shall be general purpose, enclosed plug-in type with 8-pin octal plug and protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.
 - 2. Solid State Relays (SSR):
 - a. Input/output isolation: Greater than 10^9 ohms with a breakdown voltage of 1500V root mean square or greater at 60 Hz.
 - b. Contact Life: 10×10^6 operations or greater.

- c. Ambient Temperature Range: Minus 20 to +140 degrees F.
 - d. Input impedance: Not be less than 500 ohms.
 - e. Relays shall be rated for the application. Operating and release time shall be for 100 milliseconds or less. Transient suppression shall be provided as an integral part of the relay.
3. Contactors:
- a. Type: Single coil, electrically operated, mechanically held, double-break, silver-to-silver type protected by arcing contacts.
 - b. Positive locking shall be obtained without the use of hooks, latches, or semi permanent magnets.
 - c. The number of contacts and rating shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices.

2.07 SYSTEM SOFTWARE

- A. General:
- 1. Provide all necessary system software to form a complete operating system for all operator interface devices.
 - 2. System software shall integrate with all controller software and allow management of software applications at the operator workstation.
 - 3. System software display language: English.
- B. Device Profile: Conform to the following device profiles as specified in ASHRAE/ANSI 135 BACnet Annex L:
- 1. Operator workstation: BACnet Advanced Workstation (B-AWS).
 - 2. Building Controller: BACnet Building Controller (B-C).
 - 3. Advanced Application Controller: BACnet Advanced Application Controller (B-AAC).
 - 4. Application Specific Controller: BACnet Application Specific Controller (B-ASC).
- C. Software Programming:
- 1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system shall be provided by the Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:
 - a. Text-based:
 - 1) Provide actions for all possible situations.
 - 2) Text shall be modular and structured.
 - 3) Text shall be commented.
 - b. Graphic-based:
 - 1) Provide actions for all possible situations.
 - 2) Graphics shall be documented.
 - c. Parameter-based:
 - 1) Provide actions for all possible situations.
 - 2) Parameters shall be documented.
- D. Operating System:
- 1. Concurrent, multi-tasking capability.
 - 2. Provide with the latest server operating system release.
 - 3. Common Software Applications Supported:

- a. Microsoft Windows and Microsoft Office Suite.
 - b. Open platform compatible database: Microsoft Access, Oracle Database, IBM Analytics, or other SQL database software. Proprietary databases shall not be acceptable.
- E. System Graphics:
- 1. Format.
 - a. All graphics shall be in conformance to the HCA guidelines Appendix B
 - 2. Custom Trend Logs:
 - a. Maintain trend information for 365 days
 - b. Definable for any data object in the system including interval, start time, and stop time.
 - 1) Resolution: Interval periods shall be adjustable down to one minute.
 - 2) Multiple Interval Period: Each trended point shall have the ability to be trended at a different trend interval.
 - c. Trend Data:
 - 1) Sampled and stored on the building controller panel.
 - a) Auto-Delete Period: Software shall be capable of automatically deleting stored trend data after a user-adjustable period of time. Each trended point shall have the ability to have a different auto-delete interval period.
 - 2) Retrievable for use in reports, spreadsheets and standard database programs.
 - 3) Archivable on LAN accessible storage media including the following:
 - a) Hard disk.
 - b) Raid array drive.
 - c) Virtual cloud environment.
 - 4) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
 - d. Trend Graph Display:
 - 1) Group Trend Time Series Plots:
 - a) Provide user-selectable Y-axis points.
 - b) Provide user editable titles, point names, and Y-axis titles.
 - c) Individual trended points shall be able to be grouped into groups of up to four points per plot with up to four plots per page.
 - 2) X-Y Trend Plots:
 - a) User selectable X and Y trend inputs.
 - b) User editable titles, point names, and X and Y-axis titles.
 - c) User selectable time period options:
 - i) 1-day 24-hour period.
 - ii) 1-week 7-day period.
 - iii) 1-month period with appropriate days for the month selected.
 - iv) 1-year period.
 - v) User shall be able to select the beginning and ending period for each X-Y chart, within the time domain of the database being used.
 - vi) User selectable display up to 6 plots per screen in 2 columns.
 - 3) Automatic Scaling: System shall automatically scale the axis on which trends are displayed when multiple points with different trend interval periods are selected for graphical display.

- 4) Dynamic Update: Trends shall be able to dynamically update at operator-defined intervals.
 - 5) Zoom: Software shall allow zoom-in function for detailed examination of trends.
 - e. Numeric Value Display: Software shall display value of any sample on a trend when picked.
- 3. Alarm and Event Log:
 - a. Enable all system alarms and change of states to be viewed from any system location.
 - b. List events chronologically.
 - c. List alarm priority.
 - d. Allow operator with proper security to acknowledge and clear alarms. Log operator and time when alarm is acknowledged.
 - e. Archive alarms not cleared by operator to the workstation.
- 4. Object, Property Status, and Control:
 - a. Provide a method to view, edit if applicable, the status of any object and property in the system.
 - b. Status Available by the Following Methods:
 - 1) Menu.
 - 2) Graphics.
 - 3) Custom Programs.
- 5. Clock Synchronization:
 - a. The real-time clocks in all building control panels and workstations shall be able to automatically synchronize daily from any operator-designated device in the system.
 - b. The system shall automatically adjust for daylight savings and standard time, if applicable.
- 6. Reports and Logs:
 - a. Reporting Package:
 - 1) Allows operator to select, modify, or create reports.
 - 2) Definable as to data content, format, interval, and date.
 - a) Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.
 - 3) Provide ability to obtain real-time logs of all objects available by type or status such as alarm, lockout, normal, etc.
 - 4) Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
 - 5) Allow printing on operator command or specific time(s).
 - b. Standard Report Format Options:
 - 1) Objects with current values.
 - 2) Global modification values.
 - 3) Current alarms not locked out.
 - 4) Disabled and overridden objects, points and variables.
 - 5) Objects in manual or automatic alarm lockout.
 - 6) Objects in alarm lockout currently in alarm.
 - 7) Objects currently in override status.
 - 8) Objects in Schedules
 - a) Daily.
 - b) Weekly.

- c) Holiday.
 - 9) Logs:
 - a) Alarm History.
 - b) System messages.
 - c) System events.
 - d) Trends.
 - c. Custom Report Format Intervals and Options:
 - 1) Daily.
 - 2) Weekly.
 - 3) Monthly.
 - 4) Annual.
 - 5) Time and date stamped.
 - 6) Title.
 - 7) Facility name.
 - 8) Point Groups.
 - a) User-selectable.
 - b) Group may be comprised of specific points, group of equipment objects, group of groups, or for the entire facility without restriction due to the hardware configuration of the building automation system.
 - d. Electrical, Fuel, and Weather:
 - 1) Electrical Meter(s):
 - a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
 - 2) Fuel Meter(s):
 - a) Monthly showing daily natural gas consumption for each meter.
 - b) Annual summary showing monthly consumption for each meter.
 - 3) Weather:
 - a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.
 - e. Daily Operating Condition of Chiller(s): Program a daily report that shows the operating condition of each chiller as recommended by ASHRAE Standard 147. Reference the control drawings for the points that shall be included in the log report.
7. Global Modify:
- a. Allow global modification of all editable data. Similar data shall be grouped into logical objects based on building function, mechanical system, building layout, or any other logical grouping of points.
 - b. Allow each common type of equipment to be excluded or included within the global editing process.
 - c. Display status information on all similar points in one global report.
 - d. Allow modification of the following:
 - 1) Individual data point edited.
 - 2) List of all points within the category.
 - 3) Global change field.
 - 4) Copy feature to assist in downloading the new changes.

- 5) Verification that all changes were completed.
 - e. Include a change-all feature to change all selections.
 - f. Prevent acceptance of changes until an accept icon is acknowledged.
- F. Workstation Applications Editors:
 1. Provide editing software for all workstation system applications at the PC workstation.
 2. Edited applications shall be automatically downloaded and executed at the building controller panel.
 3. Programming Description: Definition of operator device characteristics, ASC's, individual points, applications and control sequences shall be performed through fill-in-the-blank templates.
 4. System Definition/Control Sequence Documentation: All portions of system definition shall be self-documenting to provide hard copy printouts of all configuration and application data.
 5. System definition and modification procedures shall not interfere with normal system operation and control.
 6. Provide consistent text-based displays of all system point and system applications.
 7. Point identification, engineering units, status indication, and application naming conventions shall be the same at all operator devices.
 8. Full screen editor for each application shall allow operator to view and change:
 - 1) Configuration.
 - 2) Name.
 - 3) Control parameters.
 - 4) Set-points.
 - 5) Schedules.
 9. Scheduling Application Features:
 - a. Allow scheduling down to the zone or room level.
 - b. Monthly calendar indicates schedules, holidays, and exceptions.
 - c. Allows several related objects to be grouped, scheduled, and copied to other objects or dates.
 - d. Start and stop times adjustable from master schedule.
 - e. Schedule expiration.
 - f. Temporary overrides of systems with user adjustable time-out.
 - g. Provide minimum three tiers of priorities for scheduling.
 - 1) Priority 1: Event, temporary, or override.
 - 2) Priority 2: Calendar.
 - 3) Priority 3: Default.
 - h. Higher priority schedules shall overlay with lower priority schedules without interrupting or deleting them. Upon expiration of a higher priority schedule, schedule shall revert to next lower priority.
 - i. Expired priority 1 and priority 2 schedules shall be automatically deleted after execution.
 10. Custom Application Programming:
 - a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
 - b. Programming Features:
 - 1) Acceptable Languages:

- a) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
- b) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
- 2) Programming Functions:
 - a) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
 - b) Allows the development of independently, executing, program modules designed to enable and disable other modules.
 - c) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
 - d) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - e) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
 - f) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.
 - g) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.08 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
- B. System Security:
 - 1. User access secured via user passwords and user names.
 - 2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
 - 3. User Log On/Log Off attempts are recorded.
 - 4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
 - 1. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.
 - 2. Exception Schedules:
 - a. Based on any day of the year.
 - b. Defined up to one year in advance.
 - c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
 - 3. Holiday or Special Schedules:
 - a. Capability to define up to 99 schedules.
 - b. Repeated annually.
 - c. Length of each period is operator defined.

- D. System Coordination: Provide a standard application for equipment coordination. The application shall provide the operator with a method of grouping together equipment based on function and location. Groups shall be capable of being used for scheduling and other applications.
- E. Alarms:
 - 1. Provide a BAS paging and email feature with the capability to telephone/email selected facility maintenance personnel to notify them of critical BAS alarms.
 - 2. General Alarm Parameters:
 - a. Binary object is set to alarm based on the operator specified state.
 - b. Analog object to have high/low alarm limits.
 - c. All alarming is capable of being automatically or manually disabled.
 - d. Alarm Reporting:
 - 1) Operator determines action to be taken for alarm event.
 - 2) Alarms to be routed to appropriate workstation.
 - 3) Reporting Options:
 - a) Start Programs.
 - b) Print.
 - c) Logged.
 - d) Custom messaging.
 - e) Graphical displays.
 - f) Dial out to workstation receivers via system protocol.
- F. Maintenance Management:
 - 1. System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
- G. Sequencing:
 - 1. Application software based upon specified sequences of operation on the control drawings.
- H. PID Control Characteristics:
 - 1. Provide proportional-integral algorithms.
 - 2. Direct or reverse action.
 - 3. Anti-windup.
 - 4. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
 - 5. User selectable controlled variable, set-point, and PI gains.
- I. Staggered Start Application:
 - 1. Prevents all controlled equipment from simultaneously restarting after power outage.
 - 2. Order of equipment startup is user selectable.
- J. Energy Calculations:
 - 1. Refer to HCA guidelines for energy calculations and required graphics.
- K. Anti-Short Cycling:
 - 1. All binary output objects protected from short-cycling.
 - 2. Allows minimum on-time and off-time to be selected.
 - 3. Allows the number of times each piece of equipment may be cycled within any one-hour period.
- L. On-Off Control with Differential:
 - 1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
 - 2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.

- M. Trending:
 - 1. Building controllers shall allow collection and delivery of (time, value) pairs.
- N. Totalization
 - 1. Run-Time Totalization:
 - a. Totalize run-times for all binary input objects.
 - b. Provides operator with capability to assign high run-time alarm.
 - 1) Generate unique, user-specified messages when the limit is reached.
 - c. Resolution: Adjustable down to one minute.
 - 2. Pulse Totalization:
 - a. Totalize consumption for user-selected analog and binary pulse input-type objects.
 - b. Configurable for a daily, weekly, or monthly basis.
 - c. Provide calculation and storage accumulations of up to 9,999,999 units (e.g. KWH, gallons, KBTU, tons, etc.).
 - d. Resolution: Adjustable down to one minute.
 - e. Warning Limit: User definable. Generate unique, user-specified messages when the limit is reached.
 - f. The information available from the 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) Sunday through Saturday Demand kW
 - 6) Demand kW annual history for past 12 periods
 - 7) KWH annual history for past 12 periods
 - 3. Event Totalization:
 - a. Count user-selected events, such as the number of times a pump or fan system is cycled on and off.
 - b. Provide storage accumulations of up to 9,999,999 events before reset.
 - c. Warning Limit: User definable. Generate unique, user-specified messages when the limit is reached.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices and wiring is installed prior to installation proceeding.
- E. Verify the integrity of control wiring, raceways, control panels, sensors, and control devices prior to reusing for the new work.
- F. Verify wiring insulation is defect free and test wiring for continuity and ground faults.

3.02 INSTALLATION

- A. Coordination:

1. The BAS Contractor shall execute his work in such a manner as to cause the minimum interference to the operation of the building.
 2. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.
 3. Where the BAS shall share a common network backbone via a VLAN, provide temporary network access for BAS construction, startup, and commissioning. Coordinate transition of network operation to Owner's IT group.
 4. Coordinate with other contractors performing work to provide emergency power to all control devices required to operate on emergency power.
- B. Network Arrangement:
1. Use the following physical/data link communication bus for the following types of communication:
 - a. Communication between operator workstation(s) and building controller(s):
 - 1) Ethernet.
 - 2) MS/TP.
 - b. Communication between building controller(s) and application specific and custom application controllers:
 - 1) MS/TP.
 - 2) PTP.
- C. Web Services Enabled Network:
1. Provide an IP network data drop for connection of BAS into Owner's IP network. Coordinate final location of IP network data drop with the Owners' IT staff.
 2. If the Owner has no preference, within the main BAS control panel.
 3. Coordinate with the Owner's IT department to implement proper security measures, including secure access to the network data drop and firewalls at all virtual access points to the internet to protect access to the BAS.
- D. General Workmanship:
1. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.
 2. Install all equipment in readily accessible locations.
 3. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
 4. All installations shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
 5. Control wiring routed in wall cavities shall be installed in conduit.
 6. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
 7. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation.
- E. Controllers
1. Provide a separate controller for each piece of controlled equipment, such as an AHU, FCU, VAV box, etc. A controller may control more than one piece of equipment provided that all points associated with the equipment are assigned to the same BAS controller. Global points used for control loop reset are exempt from this requirement.
 2. Select building controllers and custom application controllers to provide the required I/O point capacity required to monitor all of the hardware points listed on the control drawings.
 3. Application specific controllers may be used where factory programming is capable of executing all control functions specified in the sequences of operation. Contractor shall

add supplemental controllers, devices, and programming as required to execute the specified control function if the ASC cannot.

4. All CAV/VAV Terminal Box Controller parameters to be mapped to the front end.

F. Wiring:

1. All control and interlock wiring shall comply with national and local electrical codes.
2. Wire all safety devices through both hand and auto positions of motor starting device to ensure 100 percent safety shut-off.
3. Provide interlock wiring between devices as indicated on the control drawings.
4. Provide electrical wiring for relays (including power feed) for temperature and pressure indication.
5. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.
6. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be sub-fused when required to meet Class 2 current limit.
7. Conceal all low voltage wiring in finished rooms.
8. Conceal all low voltage wiring in unfinished rooms below the elevation of the lights. Low voltage wiring above the elevation of the lights may be exposed.
9. Routing of low voltage wiring above working heights in equipment rooms and above accessible ceilings is acceptable subject to following criteria:
 - a. Wiring shall be plenum rated.
 - b. Do not lay wiring on ceiling tiles.
10. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended applications.
11. All wiring in mechanical, electrical, service rooms, or where subject to mechanical damage, shall be installed in raceway at levels below 10 feet.
12. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two wires (e.g., relays and transformers).
13. Where Class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it and neatly tied at 10 foot intervals.
14. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
15. All wire-to-device and wire-to-wire connections shall be made at a terminal block or terminal strip.
16. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
17. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, coordinate with Division 26 to provide step-down transformers.
18. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
19. Install plenum wiring in sleeves where it passes through floors and walls. Maintain fire rating at all penetrations.
20. Size of raceway and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
21. Include one pull string in each raceway 1 inch and larger.

22. Use coded conductors throughout with conductors of different colors.
23. Control and status relays shall be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
24. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6 inches from high-temperature equipment (e.g., steam pipes or flues).
25. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
26. Install insulated bushing on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.
27. Terminate all control and/or interlock wiring and maintain updated (as-built) wiring diagrams with terminations identified at the job site.
28. Terminate BAS sensor input wiring cable shield by taping back at the field device and connect shield to the grounded control panel chassis or sub-panel.
29. Terminate BAS comm bus cable shield between controllers per manufacturer recommendations.
30. Terminate management level/enterprise level network wiring cable shield by wrapping the drain wire around the foil shield and connecting the ground strip to the drain wire.
31. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 feet in length and shall be supported at each end. Flexible metal raceway less than 1/2 inch electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
32. Raceway shall be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations shall be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

G. Communication Wiring:

1. Adhere to the items listed in the "Wiring" article in Part 3 of this specification in addition to the requirements listed below.
2. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication wiring.
3. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.
4. Do not install power wiring, in excess of 30 Vac RMS, in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, use separate twisted shielded pairs with the shields grounded in accordance with the manufacturer's wiring practice.
5. Communication conduits shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible.
6. Do not exceed maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer during installation.
7. Verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
8. When a cable enters or exits a building, install a lightning arrestor between the lines and ground. Install the lightning arrestor according to the manufacturer's instructions.
9. Ground (earth ground) all shields at one point only, to eliminate ground loops.

10. All runs of communications wiring shall be unspliced length when that length is commercially available.
 11. Terminate shielded cable splices in accessible locations. Harness cables with cable ties.
 12. Make all wire-to-device and wire-to-wire connections at a terminal block or terminal strip.
 13. Label all communications wiring to indicate origination and destination data.
 14. Ground coaxial cable in accordance with NEC regulations.
 15. Install BACnet MS/TP communications wiring in accordance with ASHRAE/ANSI Standard 135
 - a. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
 - b. The maximum length of an MS/TP segment shall be 4000 ft with AWG 22 or 24 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
 - c. The maximum number of nodes per segment shall be 50. Additional nodes may be accommodated by the use of repeaters.
 - d. An MS/TP EIA-485 network shall have no T connections.
- H. Identification of Hardware and Wiring:
1. Label all wiring and cabling, including that within factory-fabricated panels, at each end within 2 inch of termination with the BAS address or termination number.
 2. Permanently label or code each point of field terminal strips to show the instrument or item served.
 3. Identify control panels with minimum 1/2 inch letters on laminated plastic nameplates.
 4. Identify all other control components with permanent labels. Label all plug-in components such that removal of the component does not remove the label.
 5. Identify room sensors related to terminal box or valves with nameplates.
 6. Maintain manufacturers' nameplates and UL or CSA labels visible and legible after equipment is installed.
 7. Identifiers shall match record documents.

3.03 STARTUP AND DEMONSTRATION

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing the BAS in permanent operation.
 1. Contractor shall provide an on-site controls technician or programmer familiar with the project BAS installation and system programming to assist the Commissioning Agent as directed during all phases of system functional testing.
 2. Coordinate with Owner the setup of logins, passwords, and security level access for individuals requiring access to the BAS.
- B. The Controls Subcontractor shall furnish the test and balance Contractor with the appropriate DDC system software available to assist in the test and balance process.
- C. The Controls Subcontractor provide a technician for 8 hours to assist/train the TAB technician in the coordination/ interface of the BAS with the TAB activities.
- D. BAS shall be set up and checked by factory trained technicians skilled in the setting and adjustment of the BAS equipment used in this project. Technicians shall be experienced in the type of HVAC systems associated with this project.
- E. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
- F. Test each control device to ensure that it is operating properly and is calibrated to the appropriate operating requirements. Run each control device through its range of operation

and sequence. Verify all normal positions are correct. Adjust and tune PID control constants to achieve proper system operation.

1. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
 2. Any tests that fail to demonstrate the operation of the BAS shall be repeated at a later date. The Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.
- G. Verify all alarms and interlocks.
1. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 2. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 3. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.
 4. Verify fire/smoke and smoke damper functionality. Verify that they respond to the proper fire alarm system general, zone, and/or detector trips.
- H. Document on system equipment schedules the final setting of controller PID constant settings, setpoints, manual reset values, maximum and minimum controller output, and ratio and bias settings in units and terminology specific to the controller. Store documentation with operator workstation.
- I. Demonstrate complete and operating system to Owner.
1. Prior to acceptance, the BAS shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
 2. The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, start-up, and debugging process.
 3. The Contractor shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. Any test equipment required to provide the proper operation shall be provided by and operated by the Contractor.
 4. Demonstrate compliance with sequences of operation through all modes of operation.
 5. Demonstrate complete operation of operator interface.
- J. Acceptance:
1. All tests described in this specification shall have been performed to the satisfaction of the Owner prior to the acceptance of the BAS as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the completion requirements if stated as such in writing by the Contractor and submitted for approval by the Owner. Such tests shall then be performed as part of the warranty.
 2. The BAS shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved.

3.04 MAINTENANCE SERVICE

- A. Provide service and maintenance of energy management and control systems for one year from Date of Substantial Completion.

3.05 TRAINING

- A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of sixteen hours on the operation and maintenance of the equipment provided under this section.

- B. Organize the training into sessions or modules for different levels of operators. Owner designated personnel shall be trained based on the level of operator training described below.
- C. Content: Training shall include but not be limited to:
 - 1. Day-to-day Operator Training:
 - a. Overview of the system and/or equipment as it relates to the facility as a whole.
 - b. Proficiently operate the BAS.
 - c. Understand BAS architecture and configuration.
 - d. Understand BAS components.
 - e. Understand system operation, including BAS control and optimizing routines (algorithms).
 - f. Operate the workstation and peripherals.
 - g. Log on and off the system.
 - h. Access graphics, point reports, and logs.
 - i. Adjust and change system set points, time schedules, and holiday schedules.
 - j. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
 - k. Understand BAS drawings and Operation and Maintenance manual.
 - l. Understand the job layout and location of control components.
 - m. Access data from BAS controllers and ASCs.
 - n. Operate portable operator's terminals.
 - o. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
 - 2. Advanced Operator Training:
 - a. Make and change graphics on the workstation.
 - b. Create, delete, and modify alarms, including annunciation and routing of these.
 - c. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals.
 - d. Create, delete, and modify reports.
 - e. Add, remove, and modify system's physical points.
 - f. Create, modify, and delete programming.
 - g. Add panels when required.
 - h. Add operator interface stations.
 - i. Create, delete, and modify system displays, both graphical and others.
 - j. Perform BAS field checkout procedures.
 - k. Perform BAS controller unit operation and maintenance procedures.
 - l. Perform workstation and peripheral operation and maintenance procedures.
 - m. Perform BAS diagnostic procedures.
 - n. Configure hardware including PC boards, switches, communication, and I/O points.
 - o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware.
 - p. Adjust, calibrate, and replace system components.
 - 3. System Manager/Administrator Training:
 - a. Maintain software and prepare backups.
 - b. Interface with job-specific, third-party operator software.

- c. Add new users and understand password security procedures.
- 4. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
- D. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.
- E. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

SECTION 23 21 13 HYDRONIC PIPING

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes piping systems for hot water heating, chilled water cooling, condenser water, make-up water for these systems, blow-down drain lines, and condensate drain piping. Piping materials and equipment specified in this Section include:
 - 1. Pipes
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 2 Section "Earthwork," for trenching and backfilling materials and methods for underground piping installations.
 - 2. Division 3 "Concrete" for concrete, reinforcement and formwork for concrete equipment pads.
 - 3. Division 7 Section "Penetration Firestopping," for materials and methods for fire barrier penetrations.
 - 4. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls.
 - 5. Division 23 Section "Identification for HVAC Piping & Equipment," for labeling and identification of hydronic piping.
 - 6. Division 23 Section "Common Work Results for HVAC" for materials and methods for wall and floor penetrations and equipment pads.
 - 7. Division 23 Section "Basic Piping Material and Methods," for materials and methods for dielectric fittings, and mechanical sleeve seals.
 - 8. Division 23 Section "General Duty Valves for HVAC Piping," for materials and methods for installing hydronic piping valves.
 - 9. Division 23 Section "Hydronic Specialties", for materials and methods for installing hydronic specialties.
 - 10. Division 23 Section "Hangers & Supports for HVAC Piping & Equipment," for insulation shields, saddles and materials and methods for hanging and supporting hydronic piping.
 - 11. Division 23 Section "HVAC Insulation," for materials and methods for insulating hydronic piping.
 - 12. Division 23 Section "HVAC Water Treatment" for water treatment equipment, controls and chemicals.
 - 13. The Division 23 Contractor shall not use mechanically joined hydronic piping systems for hydronic piping in lieu of welded, threaded or flanged piping methods.
 - a. Exception: Grooved couplings may be used at equipment connections where specified for vibration isolation control only.

1.02 SYSTEM DESCRIPTION

- A. General: The hydronic piping systems are the "water-side" of an air-and-water or all-water heating and air conditioning system. Hydronic piping systems specified in this Section include 2- or 4-pipe, hot water and chilled water piping system, and condenser water piping system. These systems are classified by ASHRAE as Low Water Temperature, Forced, Recirculating systems.
- B. 2-Pipe System: The 2-pipe system includes chilled water and hot water supply and return piping mains in a closed loop, connecting the boilers and chillers to the terminal heat transfer units by means of primary and/or secondary piping loops. Circulation is accomplished by constant or variable volume, primary and/or secondary pumps in parallel or series configuration. Design

flow rates and water temperatures are specified in the various equipment specifications and schedules. Control sequences and temperature reset schedules are specified in the temperature control specifications.

- C. 4-Pipe System: The 4-pipe system includes independent chilled water and hot water supply and return piping mains in a closed loop, connecting the boilers and chillers to the terminal heat transfer units by means of primary/secondary piping loops. Circulation is accomplished by constant or variable volume, primary and/or secondary pumps in parallel or series configuration. Design flow rates and water temperatures are specified in the various equipment specifications and schedules. Control sequences and temperature reset schedules are specified in the temperature control specifications.
- D. Condenser Water System: This system is an open piping loop connecting the chillers to the cooling tower. Circulation is accomplished by means of parallel, constant volume pumps. Design flow rates and water temperatures are specified in the various equipment specifications and schedules. Control sequences and temperature reset schedules are specified in the temperature control specifications.

1.03 SUBMITTALS

- A. Submit in accordance with Division 01 Submittals and Division 23 General Mechanical Requirements.
- B. Submit a schedule of proposed materials for each hydronic system. Include the following:
 - 1. Application (e.g., Chilled Water, Hot Water, etc.).
 - 2. Location (e.g., above grade, below grade).
 - 3. Pipe size range.
 - 4. Materials corresponding to the pipe size range.
 - 5. Connection methods (e.g., threaded, flanged, grooved, welded, etc.).
- C. Welders' certificates certifying that welders comply meet the quality requirements specified in Quality Assurance below.
- D. Certification of compliance with ASTM and ANSI manufacturing requirements for pipe and fittings.
- E. Reports specified in Part 3 of this Section.
- F. Coordination Drawings:
 - 1. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Suspended ceiling components.
 - b. Other building services.
 - c. Structural members.
- G. Record Drawings:
 - 1. As-Built Piping Diagrams: Provide drawing as follows for chilled water, condenser water, and heating hot water system and other piping systems and equipment.
 - 2. One complete set of drawings in electronic AutoCAD and pdf format.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: comply with the provisions of the following:
 - 1. ASME B 31.9 "Building Services Piping" for materials, products, and installation.
 - 2. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.
- B. Pipe and pipe fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

1.05 COORDINATION

- A. Coordinate the installation of pipe sleeves for foundation wall penetrations.

PART 2 - PRODUCTS AND MATERIALS

2.01 PIPE AND TUBING MATERIALS

- A. General: Refer to Part 3 Article "PIPE APPLICATIONS" for identification of where the below materials are used.
- B. Drawn Temper Copper Tubing: ASTM B 88, Type L.
- C. Steel Pipe:
 - 1. NPS 2 and Smaller: ASTM A 53, Type E (electric resistance welded) or Type S (seamless), Grade B, Schedule 40, black steel, plain ends.
 - 2. NPS 2-1/2 through NPS 10 ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule 40, black steel, plain ends.
 - 3. NPS 12 through NPS 24 ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule STD, black steel, plain ends.
 - a. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; seamless for NPS 2 and smaller and electric-resistance welded for NPS 2-1/2 and larger.

2.02 FITTINGS

- A. Cast-Iron Threaded Fittings: ANSI B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.
- B. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.
- C. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.
- D. Wrought-Copper Fittings: ANSI B16.22, streamlined pattern.
- E. Cast-Iron Threaded Flanges: ANSI B16.1, Class 125; raised ground face, bolt holes spot faced.
- F. Cast Bronze Flanges: ANSI B16.24, Class 150; raised ground face, bolt holes spot faced.
- G. Steel Flanges and Flanged Fittings: ANSI B16.5, Class 150 for low pressure service and Class 300 for high pressure service, including bolts, nuts, and gaskets of the following material group, end connection and facing:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt Welding.
 - 3. Facings: Raised face.
 - 4. Gasket Materials:
 - a. Steam service: Flexitallic Style CG, TEADIT Style 913, Garlock Flexseal Style RW, Lamons SpiraSeal Style WR, or Leader Style LG-13.
 - b. Chilled water, condenser water, steam condensate, and heating hot water: Style IFG 5507 as manufactured by Garlock or approved equivalent.
 - c. Refrigerants: Style IFG 5500 as manufactured by Garlock or approved equivalent.
- H. Unions: ANSI B16.39 malleable-iron, Class 150 for low pressure service and Class 300 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends. Threads shall conform to ANSI B1.20.1.
- I. Dielectric Unions, Waterway Fittings and Flanges: As specified in Division 23 "Basic Piping Materials and Methods."

2.03 JOINING MATERIALS

- A. Reference Section "Basic Piping Materials and Methods" for basic joining materials.
- B. Brazing Filler Metals: AWS A5.8, Classification BAg 1 (Silver).

1. **WARNING:** Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.

2.04 VALVES

- A. General duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division 23 Section "General-Duty Valves for HVAC Piping." Special duty valves are specified in Division 23 Section "Hydronic Specialties".

2.05 ANTIFREEZE

- A. Provide propylene glycol, as specified in Part 3, with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions to protect the piping circuit and connected equipment from physical damage from freezing or corrosion.
- B. Coordinate corrosion inhibitors with Division 23 Section "HVAC Water Treatment" to provide an integrated water treatment and piping protection solution.

PART 3 - EXECUTION

3.01 PIPE APPLICATIONS

- A. Chilled water and heating hot water may be all standard weight black steel or a mixture of Type L hard copper for piping 1" and less, steel or copper pipe from 1-1/4" to 2", and steel for piping 2-1/2" and larger. Condenser water shall be standard weight black steel.
- B. Steam piping shall be standard weight black steel. Steam condensate and pumped condensate return piping shall be schedule 80 black steel. Piping for steam and steam condensate shall be seamless; other piping may be electric-resistance welded.
- C. Type L soft copper may be used for run-outs to room terminals.
- D. Chemical feed lines shall be Schedule 80 PVC for cooling towers and Schedule 10 stainless steel for boilers.
- E. Aquatherm UV piping with an outer coating of black polyethylene may be used as an alternate on outdoor piping.

3.02 PIPING INSTALLATIONS

- A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and all branch connections. Provide long radius elbows with a minimum centerline radius of 1-1/2 times the pipe diameter. Short radius elbows with a minimum centerline radius of 1 times the pipe diameter may be used only where space does not permit the long radius elbows.
- C. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- E. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- F. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- G. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

- H. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6 inch and larger shall be sheet metal.
- I. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Division 7 Section "Penetration Firestopping" for special sealers and materials.
- J. Exterior Wall Penetrations: Seal pipe penetrations through exterior wall constructions with sleeves, packing, and sealant. Refer to Division 23 Section "Common Work Results for HVAC" for additional information.
- K. Underground Exterior Wall Penetrations: Seal pipe penetrations through underground exterior walls with sleeves and mechanical sleeve seals. Refer to Division 23 Section "Basic Piping Materials and Methods" for additional information.
- L. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 23 Section "Common Work Results for HVAC" for special sealers and materials.
- M. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.
- N. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.
- O. Install branch connections to mains using Tee fittings in main with take-off out the top or side of the main unless otherwise shown on the drawings. Up-feed risers shall have take-off out the top of the main line.
- P. Bull-head tees are prohibited. Do not install tee fittings in such a way that the flow through the branch leg equals the sum of the flows through the two main legs.
- Q. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
- R. Install flanges on valves, apparatus, and equipment having 2-1/2 inch and larger connections.
- S. Install flexible connectors at inlet and discharge connections to pumps (unless otherwise indicated) and other vibration producing equipment. Omit flexible connectors if replaced by series of three grooved couplings on projects where grooved pipe is used.
- T. Install strainers on the supply side of each pressure reducing valve, pressure regulating valve, pump, and elsewhere as indicated. Install nipple and ball valve in blow down connection of strainers 2 inch and larger.
- U. Anchor piping to ensure proper direction of expansion and contraction.

3.03 PREPARATION OF FOUNDATION FOR BELOW GROUND WATER DISTRIBUTION PIPE AND FITTINGS

- A. Grade trench bottoms to provide a smooth, firm, and stable foundation, free from rock, throughout the length of the pipe.
- B. Remove unstable, soft, and unsuitable materials at the surface upon which pipes are to be laid and backfill with clean sand or pea gravel to indicated invert elevation.
- C. Pipe Beds:
 - 1. Provide 6" thick sand pipe bed underneath and around sides of pipe, up to middle half of the pipe, including fittings. Tamp bed with mechanical tamper to 85% to 95% compaction. Provide first layer of sand backfill 6" above pipe, tamp backfill with mechanical tamper to 85% to 95% compaction.
 - 2. For piping with rock trench bottoms, provide sand pipe bed 6" underneath and around sides of pipe, including fittings.
 - 3. Provide backfill above top of pipe bed as required for field conditions. Refer to Division 15 Section

3.04 HANGERS AND SUPPORTS

- A. General: Hanger, supports, and anchors devices are specified in Division 23 Section "HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT." Conform to the table below for maximum spacing of supports:
1. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet in length.
 2. Adjustable roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 3. Pipe roller complete - MSS Type 44 for multiple horizontal runs, 20 feet or longer, supported on a trapeze.
 4. Spring hangers to support vertical runs.
 5. Provide insulation saddles and protection shields as specified in Section "Hangers & Supports for HVAC Piping & Equipment". Provide insulation inserts as specified in Section "HVAC Insulation".
- C. Install hangers with the following minimum rod sizes and maximum spacing:

Nom. Pipe Size - In.	Steel Pipe Max. Span - Ft.	Copper Tube Max. Span - Ft.	Min. Rod Dia. - In.
Up to 3/4	7	5	3/8
1	7	6	3/8
1-1/4	7	7	3/8
1-1/2	9	8	3/8
2	10	8	1/2
2-1/2	11	9	1/2
3	12	10	1/2
4	14	12	5/8 (1/2 for copper)
5	16	13	5/8 (1/2 for copper)
6	17	14	3/4 (5/8 for copper)
8	19	16	7/8 (3/4 for copper)
10	20	18	7/8 (3/4 for copper)
12	23	19	7/8 (3/4 for copper)
14	25		1
16	27		1
18	28		1 1/4
20	30		1-1/4
24	32		1-1/4
30	33		1-1/4

- D. Install PVC and CPVC supports and hangers per manufacturer's recommendations.
- E. Support vertical runs at roof, at each floor, and at maximum 15-foot intervals between floors.
- F. Install a support within one foot of each change of direction.
- G. Space supports not more than five feet apart at valves, strainers or piping accessories in piping larger than 2".

3.05 PIPE JOINT CONSTRUCTION

- A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
- B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.

2. Fill the pipe and fittings during brazing, with an inert gas (ie., nitrogen or carbon dioxide) to prevent formation of scale.
3. Heat joints using oxy-acetylene torch. Heat to proper and uniform temperature.
- C. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe fittings and valves as follows:
 1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 2. Align threads at point of assembly.
 3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
 4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
 - a. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- D. Welded Joints: Comply with the requirement in ASME Code B31.9-"Building Services Piping."
- E. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
- F. CPVC Joints: Prepare surfaces to be solvent cemented by wiping with a clean cloth moistened with acetone or methylethyl ketone. Solvent cement joints in accordance with ASTM D2846.

3.06 VALVE APPLICATIONS

- A. General Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:
 1. Shut-off duty: use gate, ball, and butterfly valves.
 2. Throttling duty: use globe, ball, and butterfly valves.
 3. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.
 4. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, elsewhere as indicated.
- B. Special Duty Valve Applications: Special duty valve applications are specified in Division 23 Section "Hydronic Specialties".

3.07 FIELD QUALITY CONTROL

- A. Preparation for testing: Prepare hydronic piping in accordance with ASME B 31.9 and as follows:
 1. Leave joints including welds uninsulated and exposed for examination during the test.
 2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
 3. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
 4. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.
- B. Pressure Testing: Test hydronic piping as follows:

1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
 2. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of the liquid.
 3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
 4. Subject piping systems other than ground source heat pump loop systems to a hydrostatic test pressure which at every point in the system is 1.5 times the maximum system design pressure but not less than 100 psi. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in Appendix I of ASME B31.9, Code For Pressure Piping, Building Services Piping.
 5. After the hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.
 6. Subject ground source heat pump loop systems to water test pressure of 100 psi for 30 minutes. Testing shall be implemented prior to trench backfilling. Compare actual flow and pressure drop to design values and make system corrections as required to bring actual values to within 10% of design.
 7. Provide test reports summarizing the test procedures and results of the tests.
- C. Flushing:
1. After satisfactory pressure test is obtained, flush piping system using a minimum velocity of 4 FPS through all portions of the system.
 2. Make all provisions required to isolate HVAC equipment, coils, control valves, automatic flow control valves, pressure independent control valves, and balance valves during flushing.
 3. Isolate new pipe from existing pipe during flushing.
 4. Provide temporary valves, connections, and bypasses where required.
 5. System pumps may be used for flushing. Where system pumps are not used, provide temporary pumps with temporary connections.
 6. Continue flushing until discharge water shows no discoloration and strainers are no longer collecting dirt and other foreign materials.
 7. Upon completion of flushing, drain all water from system at low points, and remove, clean, and replace strainers.
- D. Fluid Testing: After filling the system as described under Paragraph "Startup", perform the following fluid test procedures:
1. Circulate the fluid for a minimum of 24 hours with all pumps operating and with shutoff valves and control valves in wide open position to ensure thorough mixing of the antifreeze or glycol solution throughout the system.
 2. Remove fluid from a minimum of three different locations and test fluid samples at an independent testing agency for percentage of antifreeze or glycol. Coordinate with the testing agency for amount of sample needed for proper testing.
 3. If any sample does not meet the specified percentages, remove sufficient fluid from the system, add antifreeze or glycol as required to achieve the specified percentage and repeat the circulation and testing procedures specified above.

4. After the samples meet the specified percentages, submit to the Owner and Engineer signed and dated test report(s) from independent testing agency that document the location of the sample and the results of the fluid test.
5. One month prior to end of the warranty period, Contractor shall submit samples to an independent testing agency to test the fluid for percentage of antifreeze or glycol. If the test samples have the specified percentage, submit copies of the test reports to the Owner and Engineer as described above in Paragraph 4. If any sample does not meet the specified percentage, Contractor shall perform the work described above in Paragraphs 3 and 4.

3.08 ADJUSTING AND CLEANING

- A. Concentration:
 1. As recommended by manufacturer.
- B. Hot Water Heating Systems:
 1. Apply heat while circulating, slowly raising temperature to 160 F and maintain for 12 hours minimum.
 2. Remove heat and circulate to 100 F or less, drain systems as quickly as possible.
 3. Refill with clean water and repeat until system cleaner is removed.
- C. Chilled Water and Closed Loop Condenser Water Systems:
 1. Circulate for 48 hours, then drain systems as quickly as possible.
 2. Refill with clean water, circulate for 24 hours, then drain.
 3. Refill with clean water and repeat until system cleaner is removed.
- D. Use neutralizer agents on recommendation of system cleaner supplier and approval of Engineer.
- E. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.
- F. Remove and clean or replace strainer screens.
- G. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.
- H. After cleaning system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.
- I. Mark calibrated name plates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

3.09 HEATING AND COOLING WATER FLUSHING

- A. Before startup of new chilled water or heating systems perform cleaning, flushing and draining procedures designed to clean and verify by testing that the systems are clean prior to circulating through new clean components, control valves, coils, pumps, etc. or connecting the new system to an existing system. Utilize flushing connections at AHU coils, chillers, and at end-of-mains for hot water piping. Close valves at coils and chillers and flush systems through equipment/coil bypass connections. Drawings shall show flushing bypass connections and valves at all coils and equipment. Show flushing connections in hot water piping at end of piping run(s) on each floor and at major branches on the ancillary floors. After flushing systems, close flushing valves, cut bypass connections and cap piping at end of flushing valves. On VAV boxes, open valves to boxes and flush through hose bib connection at each box y-strainer.
- B. Cleanness of the system shall be determined by water sampling performed by the water management chemical engineer and witnessed and approved in writing by the General Contractor's quality control representative.
- C. Permanent facility pumps should not be used for circulating the cleaning water. However if it is impractical to use temporary pumps, the permanent facility pump may be used provided

that the pump is unconditionally warranted for two years, parts and labor, after the date of substantial completion by the mechanical contractor.

3.10

3.11 STARTUP

- A. Fill system and perform initial chemical treatment. For systems with antifreeze or glycol, fill systems with specified percentages.
- B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
- C. Before operating the system perform these steps:
 - 1. Open valves to full open position. Close coil bypass valves.
 - 2. Remove and clean strainers.
 - 3. Check pump for proper direction of correct improper wiring.
 - 4. Set automatic fill valves for required system pressure.
 - 5. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
 - 6. Set temperature controls so all coils are calling for full flow.
 - 7. Check operation of automatic bypass valves.
 - 8. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
 - 9. Lubricate motors and bearings.

END OF SECTION 23 21 13

SECTION 23 21 16 HYDRONIC SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes hydronic specialties for hot water heating, chilled water cooling, condenser water, make-up water for these systems, blow-down drain lines, and condensate drain piping. Equipment specified in this Section include:
 - 1. Circuit Balancing Valves
 - 2. Automatic Flow-Control Valves
 - 3. Safety Relief Valves
 - 4. Pressure Reducing Valves
 - 5. Air Vents (Manual and Automatic)
 - 6. Diverting Fittings
 - 7. Y-Pattern Strainers
 - 8. Basket Strainers
 - 9. Metal Flexible Connectors
 - 10. Rubber Flexible Connectors
 - 11. Combination Piping Packages (Coil Kits).
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 3 "Concrete" for concrete, reinforcement and formwork for concrete equipment pads.
 - 2. Division 23 Section "Common Work Results for HVAC" for materials and methods for wall and floor penetrations and equipment pads.
 - 3. Division 23 Section "Basic Piping Material and Methods," for materials and methods for flexible connectors and mechanical sleeve seals.
 - 4. Division 23 Section "Common Motor Requirements for HVAC Equipment" for motors related to chemical feeding equipment.
 - 5. Division 23 Section "Hydronic Piping" for material and methods for installation of hydronic piping systems.
 - 6. Division 23 Section "General Duty Valves for HVAC Piping," for materials and methods for installing hydronic piping valves.
 - 7. Division 23 Section "Hangers & Supports for HVAC Piping & Equipment," for insulation shields, saddles and materials and methods for hanging and supporting hydronic piping.
 - 8. Division 23 Section "HVAC Insulation," for materials and methods for insulating hydronic piping.
 - 9. Division 23 Section "HVAC Water Treatment" for water treatment equipment, controls and chemicals.
 - 10. Division 23 Section "Instrumentation and Control Devices for HVAC" for control valves.

1.02 SUBMITTALS

- A. Submit in accordance with Division 01 Submittals and Division 23 General Mechanical Requirements.
- B. Product Data, including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions for each hydronic specialty and special duty valve specified.

1. Furnish flow and pressure drop curves for diverting fittings and circuit balancing valves, based on manufacturer's testing.
2. Cooling tower basin sweeper piping layout and assembly drawings for basin sweeper systems. Include all dimensions, piping, water jets, couplings, valves, pressure gauges, and other components required to assemble the complete sweeper system inside the cooling tower basin.
- C. Maintenance Data for hydronic specialties and special duty valves, for inclusion in operating and maintenance manual specified in Division 1 and Division 23 Section "General Mechanical Requirements."
- D. Welders' certificates certifying that welders comply meet the quality requirements specified in Quality Assurance below.
- E. Certification of compliance with ASTM and ANSI manufacturing requirements for hydronic specialties.

1.03 QUALITY ASSURANCE

- A. ASME B 31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
- B. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers; Current Edition.
- C. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.
- D. Pipe specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.
- E. AWWA Standards for governing filter media; American Water Works Association, Current Edition.
- F. NSF Standards for governing filter media; National Sanitation Foundation (NSF) International, Current Edition.

1.04 COORDINATION

- A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide hydronic piping system products from one of the following:
 1. Circuit Balancing Valves:
 - a. American Wheatley.
 - b. Armstrong Fluid Technology.
 - c. Bell & Gossett; Xylem.
 - d. Caleffi.
 - e. Griswold Controls.
 - f. Hays Fluid Controls.
 - g. IMI Hydronic Engineering.
 - h. Nexus Valve.
 - i. Nibco Inc.
 - j. Pro Hydronic Specialties.
 - k. Taco, Inc.

- I. Victaulic (TA Series).
- 2. Safety Relief Valves:
 - a. American Wheatley.
 - b. Armstrong International.
 - c. Bell & Gossett; Xylem.
 - d. Caleffi.
 - e. Keckley.
 - f. Spence Engineering Company, Inc.
 - g. Spirax Sarco.
 - h. Watts Water Technologies.
- 3. Pressure Reducing Valves:
 - a. American Wheatley.
 - b. Armstrong International.
 - c. Bell & Gossett; Xylem.
 - d. Caleffi.
 - e. Keckley.
 - f. Spence Engineering Company, Inc.
 - g. Watts Water Technologies.
- 4. Air Vents (manual and automatic):
 - a. American Wheatley.
 - b. Amtrol, Inc.
 - c. Armstrong International.
 - d. Bell & Gossett; Xylem.
 - e. John Wood Company.
 - f. Nexus Valves.
 - g. Spirax Sarco.
 - h. Taco, Inc.
- 5. Diverting Fittings:
 - a. Amtrol, Inc.
 - b. Armstrong Fluid Technology.
 - c. Bell & Gossett; Xylem.
 - d. Taco, Inc.
- 6. Y-Pattern Strainers:
 - a. American Wheatley.
 - b. Armstrong International.
 - c. Hoffman Specialty; Xylem.
 - d. Keckley.
 - e. Metraflex Co.
 - f. Mueller Steam Specialties.
 - g. Spirax Sarco.
 - h. Nexus Valve.
 - i. Watts Water Technologies.
- 7. Basket Strainers:
 - a. American Wheatley.

- b. Keckley.
- c. Metraflex Co.
- d. Spirax Sarco.
- 8. Metal Flexible Connectors:
 - a. American Wheatley.
 - b. Duraflex.
 - c. Hyspan Precision Products.
 - d. Mason Industries, Inc.
 - e. Flexicraft Industries.
 - f. Metraflex Co.
 - g. Unaflex, Inc.
- 9. Rubber Flexible Connectors:
 - a. American Wheatley.
 - b. General Rubber Corp.
 - c. Mason Industries, Inc.
 - d. Mercer Rubber Co.
 - e. Metraflex Co.
 - f. Proco Products, Inc.
 - g. Unaflex, Inc.
 - h. Duraflex.
 - i. Flexicraft Industries.

2.02 GENERAL DUTY VALVES

- A. General duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division 23 Section "General-Duty Valves for HVAC Piping." Special duty valves are specified below by their generic name; refer to Part 3 Article "VALVE APPLICATION" for specific uses and applications for each valve specified.

2.03 SPECIAL DUTY VALVES

- A. Circuit Balancing Valves: Valve shall be rated for 125 psig water working pressure, 250 deg F maximum operating temperature and shall be bronze body with plug or globe style valve and calibrated orifice. Provide with connections for portable differential pressure meter with integral check valves and seals. Valve shall have integral pointer and calibrated scale to register degree of valve opening. Valve shall have position indication readout and built-in memory stop for repeatable regulation and control. Valves 2 inch and smaller shall have threaded connections and 2-1/2 inch valves shall have flanged connections.
- B. Triple Duty Valves: Valve shall be rated for 125 psig working pressure, 300 deg F maximum operating temperature, and shall be cast-iron body with bronze disc and seat, stainless steel stem and spring, and "Teflon" packing. Valves shall have flanged connections and straight or angle pattern as indicated. Features shall include non-slam check valve with spring-loaded weighted disc, and calibrated adjustment feature to permit regulation of pump discharge flow and shutoff.
- C. Pressure Reducing Valves: Valve shall be diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and non-corrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment.
- D. Safety Relief Valves: Valve shall be rated for 125 psig working pressure and 250 deg F maximum operating temperature; designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body

shall be cast-iron, with all wetted internal working parts made of brass and rubber. Select valve to suit actual system pressure and Btu capacity.

- E. Combined Pressure/Temperature Relief Valves: Valve shall be diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and non-corrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment. Safety relief valve designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made of brass and rubber; 125 psig working pressure and 250 deg F maximum operating temperature. Select valve to suit actual system pressure and Btu capacity. Provide with fast fill feature for filling hydronic system.
- F. Automatic Flow Control Valves: Valve shall be Class 150, cast iron housing, stainless steel operating parts; threaded connections for 2 inch and smaller, flanged connections for 2-1/2 inch and larger. Factory set to automatically control flow rates within plus or minus 5 percent design, while compensating for system operating pressure differential of 2 through 32 psi. Provide quick disconnect valves for flow measuring equipment. Provide a metal identification tag with chain for each valve, factory marked with the zone identification, valve model number, and flow rate in GPM.

2.04 HYDRONIC SPECIALTIES

- A. Manual Air Vent: Manual air vents at heat transfer coils shall be bronze body and nonferrous internal parts; 150 psig working pressure, 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; and having 1/8 inch discharge and inlet connections. Manual air vents in piping mains shall consist of a tee fitting, 1/2" ball valve, threaded nipple and cap.
- B. Automatic Air Vent: Automatic air vents shall be designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150 psig working pressure, 240 deg F operating temperature; and having 1/4 inch discharge connection and 1/2 inch inlet connection.
- C. Diverting Fittings: Diverting fittings shall have cast iron body with threaded ends, or wrought copper with solder ends; and shall be rated for 125 psig working pressure, 250 deg F maximum operating temperature. Indicate flow direction on fitting.
- D. Y-Pattern Strainers: Strainers shall be rated for 125 psig working pressure and shall have perforated Type 304 stainless steel basket and bottom drain connection. For general piping strainers, screen openings shall be 0.062" perforations for 4" and smaller and 1/8" perforations for larger than 4". For strainers upstream of automatic flow control valves, screen openings shall be 20 mesh. Strainers, 2" and smaller, shall have cast bronze body (ASTM B-62), threaded connections and screwed cover. Strainers, larger than 2", shall have cast-iron body (ASTM A 126, Class B), flanged or grooved ends and bolted cover.
- E. Basket Strainers:; Strainer shall have high tensile cast-iron body (ASTM A 126, Class B) rated for 125 psig working pressure, flanged end connections, bolted cover, perforated Type 304 stainless steel basket, and bottom drain connection.
- F. T-Pattern Strainers:; Strainer shall have ductile iron or malleable iron body rated for 150 psi working pressure, grooved end connections, Type 304 stainless steel strainer basket with 57 percent free area; removable access coupling and end cap for strainer maintenance.
- G. Flexible Connectors: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections.
 - 1. Flexible Connectors (Hydronic System equipment connections 4" and larger): Stainless-steel bellows with woven, flexible, stainless steel, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4-inch (20-mm) misalignment.
 - 2. Spherical, Rubber, Flexible Connectors (Hydronic System equipment connections 4" and larger): Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150

- and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.
3. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors (Hydronic System equipment connections smaller than 4"): Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.
 4. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors (Hydronic System equipment connections smaller than 4"): Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.
 5. Rubber, Flexible Connectors (Hydronic System equipment connections smaller than 4"): CR or EPDM elastomer rubber construction, with multiple piles of NP fabric, molded and cured in hydraulic presses. Include 125-psig minimum working-pressure rating at 220 deg F. Units may be straight or elbow type, unless otherwise indicated.
- H. Combination Piping Packages (Coil/Hose Kits):
1. Combination piping packages are allowed in lieu of individual components specified for hydronic coils and devices containing hydronic coils.
 2. Components shall be same size as piping serving the unit as shown on the drawings. Control valves do not need to be same size as piping subject to the sizing requirements set forth in Division 23 "Instrumentation and Control Devices for HVAC."
 3. Package shall include the components and shall match layouts specified on the Drawings. Each component of the combination piping package shall meet the specifications for the individual components being combined.

PART 3 - EXECUTION

3.01 VALVE APPLICATIONS

- A. General Duty Valve Applications: General duty valve applications are specified in Division 23 Section "Hydronic Piping".
- B. Circuit Balancing Valves:
 1. Constant Volume Pumping Systems:
 - a. Install circuit balancing valves where shown on the drawings and elsewhere as required to facilitate system balancing.
 2. Variable Volume Pumping Systems:
 - a. Install circuit balancing valves where shown on the drawings sized for the smaller of the following:
 - 1) Line size.
 - 2) A minimum pressure drop of 1 psi at the design flow rate.
- C. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.
- D. Install check valves on each pump discharge and elsewhere as required to control flow direction.
- E. Install pump discharge valves with stem in upward position; allow clearance above stem for check mechanism removal.
- F. Install safety relief valves on hot water generators, and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge to floor without valves. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 1 for installation requirements.
- G. Install pressure reducing valves on hot water generators, and elsewhere as required to regulate system pressure.

3.02 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in the system, at heat transfer coils, and elsewhere as required for system air venting.

- B. Install automatic air vents at air separator outlets, expansion tank connections, high points in outlet piping of boilers and hot water heat exchangers and elsewhere as required for system air venting. Pipe outlet of automatic air vents to discharge at floor drains.
- C. Install strainers on the supply side of each pressure reducing valve, pressure regulating valve, pump, and elsewhere as indicated. Install nipple and ball valve in blow down connection of strainers 2 inch and larger.
- D. On constant volume pumping system, each pumped system shall have a means of balancing the flow. Avoid the use of automatic flow regulating devices. Butterfly valves shall not be used for balancing. Balancing valves shall be specifically manufactured for flow balancing and shall be equipped with pressure measurement taps and shall be provided with flow vs. pressure drop chart. Insure balancing valves are installed with manufacturer's recommended straight lengths of pipe, usually 1.5 to 2 pipe diameters.
- E. On variable flow systems, i.e. pumps with VFDs, use a separate check and isolation valve. Balancing or combination valve is not required.
- F. Provide inlet strainer, PT plugs, and air vent in piping connection to each coil. Balancing valves are required at each air handler coil but not at individual terminal box reheat coils. Ball shut-off valves on reheat coils shall be provided with memory stops.
- G. For AHU's with multiple coils, provide only a single balancing valve to serve the multiple coils. Install with recommended straight pipe lengths before and after balancing valves.
- H. Use manual air vents throughout the chilled and hot water heating systems. Avoid use of automatic air vents except where recommended at bladder type expansion tanks.
- I. PT test plugs shall be located at each hydronic BAS temperature sensor and at the entering and leaving connections of coils, chillers, hot water boilers and heat exchangers.
- J. Contractor to provide facility with a PT measurement kit with thermometers and gages chosen to indicate system pressures and temperatures at mid-scale.
- K.

3.03 TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water filtration equipment and/or glycol makeup equipment.
- B. Training for Owner's personnel shall include but not be limited to:
 - 1. Overview of the system and /or equipment as it relates to the facility as a whole.
 - 2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
- C. Review manufacturer's safety data sheets for handling of chemicals.
- D. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Division 1 and Division 23 Section "General Mechanical Requirements."
- E. Schedule at least four hours of training with Owner, through Architect, with at least seven days' advance notice.
- F. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

END OF SECTION 23 21 16

SECTION 23 22 16

STEAM AND CONDENSATE PIPING SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes steam and condensate piping specialties for low, medium and high pressure steam and condensate piping for building HVAC systems. Materials and equipment specified in this Section include:
 - 1. Piping specialties
 - 2. Special duty valves
 - 3. Steam traps
 - 4. Flash tanks
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for materials and methods for providing means of expansion.
 - 2. Division 23 Section "Identification for HVAC Piping & Equipment," for labeling and identification of equipment.
 - 3. Division 23 Section "Common Work Results for HVAC" for materials and methods for equipment pads.
 - 4. Division 23 Section "Basic Piping Material and Methods," for materials and methods for flexible connectors and mechanical sleeve seals.
 - 5. Division 23 Section "General Duty Valves for HVAC Piping," for materials and methods for installing steam and condensate piping valves.
 - 6. Division 23 Section "Hangers & Supports for HVAC Piping & Equipment," for insulation shields, saddles and materials and methods for hanging and supporting steam and condensate piping specialties.
 - 7. Division 23 Section "HVAC Insulation," for materials and methods for insulating steam and condensate piping specialties.
 - 8. Division 23 Section "Hydronic Piping" for dielectric unions, waterway fittings and flanges.

1.02 DEFINITIONS

- A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).
- B. Low Pressure Steam Systems operate at 15 psig (100 kPa above atmospheric) and under.
- C. Medium Pressure Steam Systems operate between 15 psig (100 kPa above atmospheric) and 60 psig (414 kPa above atmospheric).
- D. High Pressure Steam Systems between 60 psig (414 kPa above atmospheric) and 125 psig (861 kPa above atmospheric).

1.03 SUBMITTALS

- A. Product data, including rated capacities where applicable, furnished options and accessories, and installation instructions for:
 - 1. Safety Relief Valves.
 - 2. Pressure Reducing Valves.

3. Steam Traps, including recommended safety factor sizing information.
 4. Thermostatic Air Vents.
 5. Strainers.
 6. Vacuum Breakers.
 7. Metal Flexible Connectors.
 8. Flash Tanks
- B. Shop drawings, detailing dimensions, methods of assembly of components, and location and size of each field connection for steam and condensate specialties.
- C. Maintenance data, including data for steam and condensate specialties and special duty valves. Refer to Division 1 and Division 23 Section "General Mechanical Requirements" for detailed requirements.
- D. Welders' certificates certifying that welders comply meet the quality requirements specified in Quality Assurance below.
- E. Certification of compliance with specified ASTM, ASME, and ANSI manufacturing requirements for piping specialties.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: comply with the provisions of the following:
1. ASME B 31.9 "Building Services Piping: for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
 2. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.
- B. Piping specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide steam and condensate piping system products from one of the following:
1. Safety Pressure Relief Valves:
 - a. Armstrong International
 - b. Kunkle Valve Co., Inc.
 - c. Spence Engineering
 - d. Spirax Sarco.
 - e. Watts Regulator Co.
 2. Pressure Reducing Valves:
 - a. Hoffman Specialty ITT; Fluid Handling Div.
 - b. Leslie Controls
 - c. Spirax Sarco.
 3. Steam Traps:

- a. ITT Hoffman
- b. Spirax Sarco.
- c. Watson McDaniel
- 4. Thermostatic Air Vents:
 - a. Hoffman Specialty ITT; Fluid Handling Div.
 - b. Spirax Sarco.
- 5. Strainers:
 - a. Hoffman Specialty ITT; Fluid Handling Div.
 - b. Spirax Sarco.
- 6. Metal Flexible Connectors:
 - a. Hyspan Precision Products
 - b. Mason Industries, Inc.
 - c. Metraflex Co.
 - d. Proco Products, Inc.
 - e. Duraflex
 - f. Flexicraft Industries
- 7. Vacuum Breakers
 - a. Armstrong International
 - b. ITT Hoffman
 - c. Spirax Sarco
- 8. Flash Tanks:
 - a. Armstrong International
 - b. Penn Separator Corporation.
 - c. Precision Boilers.
 - d. Wendland Manufacturing Co.

2.02 SPECIAL DUTY VALVES

- A. Special duty valves are specified in this Article by their generic name; refer to Part 3 below, Article "VALVE APPLICATION" for specific uses and applications for each valve specified.

2.03 SAFETY RELIEF VALVES

- A. General: Select steam safety valves for full relief of capacity of equipment served, in accordance with ASME Boiler and Pressure Vessel Code. Furnish complete with cast iron drip-pan elbow having threaded inlet and outlet with threads (FPT) conforming to ANSI B1.20.1; sized for full size of safety valve outlet connection.
- B. Bronze Safety Valves: Valve shall have Class 250 cast bronze body with threaded (MPT) inlet and threaded (FPT) outlet; forged copper alloy disc, fully enclosed cadmium plated steel spring having an adjustable pressure range and positive shut-off. Factory-set valves to relieve at 10 psi above operating pressure.
- C. Cast-Iron Safety Valves: Valve shall have Class 250 cast iron body and bronze seat, forged copper alloy disc and nozzle; fully enclosed stainless steel spring having an adjustable pressure

range and positive shut-off; threaded end connections for valves 2 inch and smaller, raised face flanged inlet and threaded outlet connections for valves 2-1/2 inch and larger. Factory-set valves to relieve at 10 psi above operating pressure.

2.04 PRESSURE REDUCING VALVES

- A. General: Select pressure reducing valves of size, capacity, and pressure rating as scheduled. Factory-set for inlet and outlet pressures as indicated.
- B. Valves Characteristics: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shut-off; cast iron body with flanged end connections for 2 1/2-inches and larger and threaded end connections for 2-inches and smaller, hardened stainless steel trim, and replaceable valve head and seat.

2.05 BACK PRESSURE REGULATING VALVES

- A. General: Select back pressure regulating valves of size, capacity, inlet (upstream) pressure, pressure drop, pressure rating, and operating temperature. Valves shall be factory-set for inlet and outlet pressures as indicated.
- B. Valve Characteristics: Pilot actuated, diaphragm type with adjustable pressure range and positive shutoff; cast iron body with flanged end connections; stainless steel seats, discs and stems; steel spring; non-asbestos gasket; normally closed operation; and +/- 1 psig accuracy.
- C. Manufacturer:
 - 1. Spence Engineering Co., model E5Q
 - 2. Approved equal.

2.06 STEAM TRAPS

- A. General: Size steam traps for the load served including manufacturer's recommended safety factors for the application and location except when a safety factor is specified on the drawings. Include manufacturer's recommended safety factor sizing information in the steam trap submittal.
- B. Thermostatic Traps: Trap shall have cast brass, angle pattern body, with integral union tailpiece and screw-in cap; maximum operating pressure of 25 psig; balanced pressure stainless steel or Monel diaphragm or bellows element, with renewable hardened stainless steel valve head and seat.
- C. Float and Thermostatic Traps (below 15 psig): Trap shall have ASTM A 48 or A 126, Class 30 cast iron body and bolted cap; renewable, stainless steel float mechanism, with renewable, hardened stainless steel head and seat; balanced pressure thermostatic air vent made of stainless steel or Monel bellows with stainless steel head and seat. Capacity as indicated on the plans with 0.5 psi differential pressure.
- D. Float and Thermostatic Traps (15 psig and higher): Trap shall have ASTM A 48, cast iron body and bolted cap; maximum design pressure of 175 psig; renewable, stainless steel float mechanism, with renewable, hardened stainless steel head and seat; balanced pressure thermostatic air vent made of stainless steel capable of operation with 45 degree F superheat. Provide with integral vacuum breaker. Capacity as indicated on the plans with differential pressure at one half operating pressure.
- E. Inverted Bucket Traps: Trap shall have ASTM A 48 or A 126, Class 30 cast iron body and cap, pressure rated for 250 psi; stainless steel head and seat; stainless steel valve retainer, lever, guide pin assembly, brass or stainless steel bucket.
 - 1. Provide integral stainless steel inlet strainer within trap body if strainer is not provided in the inlet piping to the trap.

2.07 THERMOSTATIC AIR VENTS

- A. Quick Vents: Vent shall have cast iron or brass body, with balanced pressure stainless steel or Monel thermostatic bellows, and stainless steel heads and seats.
- B. Float Vents: Vent shall have cast iron or brass body; seamless stainless steel float; balance pressure thermostatic bellows; replaceable stainless steel seat, float, and head.

2.08 STRAINERS

- A. Y-Pattern Strainers:
 - 1. Pressure Class: Minimum 125 psig.
 - 2. Construction: Cast iron body conforming to ASTM A 126.
 - 3. End Connection: Threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger.
 - 4. Accessories:
 - a. Grade 18-8 stainless steel screen:
 - 1) 0.045 inch perforations for 10 inch and smaller.
 - 2) 0.062 inch perforations for sizes 12 inch and larger.
 - b. Tapped blow-off plug.
- B. Basket Strainers:
 - 1. Pressure Class: Minimum 125 psig.
 - 2. Construction: Cast iron body conforming to ASTM A 126.
 - 3. End Connection: Flanged.
 - 4. Accessories:
 - a. Grade 18-8 stainless steel screen.
 - b. Bolted cover.

2.09 FLEXIBLE CONNECTORS

- A. Flexible Connectors (Steam System equipment connections 4" and larger): Stainless-steel bellows with woven, flexible, stainless steel, wire-reinforcing protective jacket; minimum working pressure and maximum operating temperature compatible with steam or condensate operating conditions. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4-inch (20-mm) misalignment.
- B. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors (Steam System equipment connections smaller than 4"): Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose. Minimum working pressure and maximum operating temperature shall be compatible with steam or condensate operating conditions.

2.10 FLASH TANKS

- A. Construct flash tanks of welded steel in accordance with ASME Boiler and Pressure Vessel Code, for 150 psig rating. Fabricate all welds and tapings for vents, steam and condensate outlets of pressure indicated on the drawings, high pressure condensate inlet, air vent, safety valve, and legs prior to application of ASME label.

2.11 VACUUM BREAKERS

- A. Cast iron, bronze or stainless steel body with threaded connections; stainless steel sealing ball, retainer spring and screen; EPR O-ring seal; and pressure and temperature ratings of 125 psig and 350 degrees F.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

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

3.02 PIPING SPECIALTY INSTALLATIONS

- A. Install flexible connectors at inlet and discharge connections to pumps and other vibration producing equipment as indicated.
- B. Install strainers on the supply side of each control valve, pressure regulating valve, solenoid valve, traps, and elsewhere as indicated. Install strainers in the horizontal position. Install 3/4 inch NPS nipple and ball valve in blow down connection of strainers 2 inch and larger. Use same size nipple and valve as blow-off connection of strainer.
- C. Install steam traps close to drip legs.
- D. Flash Tanks: Pitch condensate lines towards flash tank. If more than one condensate line discharges into flash tank, install a swing check valve in each line. Install a thermostatic air vent at the top of the tank. Install an inverted bucket or float and thermostatic trap at the low pressure condensate outlet, sized for triple the condensate load. Install a safety relief valve at the tank top. Install a pressure gage, gate valve, and swing check valve on the low pressure (flash) steam outlet.

3.03 HANGERS AND SUPPORTS

- A. Hanger, supports, and anchors devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

3.04 STEAM TRAP INSTALLATIONS

- A. Install steam traps in accessible locations as close as possible to connected equipment. Maximum allowable distance from equipment is 4 feet.
 - 1. Unless otherwise indicated, install gate valve (or full-port ball valve for low pressure steam and condensate), strainer, and union upstream from the trap; install union, check valve, and gate valve downstream from trap.

3.05 PRESSURE REDUCING VALVE INSTALLATIONS

- A. General: Install pressure reducing valves as required to regulate system pressure. Install in a location readily accessible for maintenance and inspection.
- B. Size reducing valves to supply the maximum steam requirements of the heating system or equipment indicated, at the indicated inlet and outlet pressures.
- C. Provide bypass around each reducing valve, with a globe valve equal in size to the area of the reducing valve seat ring.
- D. Install gate valves and unions around each reducing valve to facilitate removal and repair of reducing valves. Unions may be omitted for reducing valves with flanged connections.
- E. Install pressure gages on the low pressure side of each reducing valve and ahead of the shutoff valve plus one downstream for the shutoff valve.
 - 1. On two-stage reducing stations, install a drip trap and pressure gage upstream from the second stage reducing valve.
- F. Install strainers upstream of each reducing valve.
 - 1. On two-stage reducing stations omit the strainer upstream from the second stage, unless specifically indicated otherwise.

- G. Install safety valves downstream from each reducing valve set at 10 psig higher than the reduced pressure.

3.06 SAFETY VALVE INSTALLATIONS

- A. Install relief valves in accordance with and where required by ASME B 31.1 - "Power Piping." Pipe discharge to atmosphere outside the building, without stop valves. Terminate vent pipe with screened vent cap. Install a drip pan elbow fitting adjacent to the safety valve. Pipe drip pan elbow drain connection to the nearest floor drain without valves. Comply with ASME Boiler and Pressure Vessel Code for installation requirements.

3.07 TERMINAL HEATING AND COOLING EQUIPMENT CONNECTIONS

- A. Install vacuum breaker downstream from the control valve and bypass, and as close as possible to the coil inlet connection.

END OF SECTION 23 22 16

SECTION 23 31 13 METAL DUCTS

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

A. This Section includes:

1. Rectangular, round, and flat-oval metal ducts and plenums for heating, ventilating, and air conditioning systems in pressure classes from minus 2 inches to plus 10 inches water gauge.
2. Duct liner.
3. Factory-fabricated grease exhaust ductwork.
4. Wire rope hanging system.

B. Related Sections:

1. Division 7 Section "Penetrations Firestopping," for materials and methods for fire barrier penetrations.
2. Division 7 Section "Joint Sealers," for materials and methods for sealing duct penetrations through basement and foundation walls.
3. Division 23 Section "Identification for HVAC Piping & Equipment," for labeling and identification of metal ducts.
4. Division 23 Section "Common Work Results for HVAC," for materials and methods for wall penetrations and equipment pads.

1.02 DEFINITIONS

A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:

1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
2. Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

- A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

1.04 SUBMITTALS

- A. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:

1. Duct Liner.
2. Sealing Materials.

3. Fire-Stopping Materials.
- B. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:
1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
 2. Duct layout, indicating pressure classifications, duct gauge and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled as defined in this Section.
 3. Fittings.
 4. Reinforcing details and spacing.
 5. Seam and joint construction details.
 6. Penetrations through fire-rated and other partitions.
 7. Terminal heating and cooling unit, coil, humidifier and duct silencer installations.
 8. Locations of fire and fire/smoke dampers and associated duct access doors.
 9. Locations of cleanout and access doors in grease exhaust ducts.
 10. Location of manual balancing dampers.
 11. Duct smoke detector locations. Refer to electrical drawings for general locations and coordinate locations with the electrical contractor.
 12. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
- C. Coordination drawings for ductwork installation in accordance with Division 23 Section "General Mechanical Requirements." In addition to the requirements specified in "General Mechanical Requirements" show the following:
1. Coordination with ceiling suspension members.
 2. Spatial coordination with other systems installed in the same space with the duct systems.
 3. Coordination of ceiling- and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
 4. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.
- D. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 23 Section "General Mechanical Requirements" and Division 1.
- E. Welding certificates including welding procedures specifications, welding procedures qualifications test records, and welders' qualifications test records complying with requirements specified in "Quality Assurance" below.

1.05 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."
- B. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.
- C. NFPA Compliance: Comply with the following NFPA Standards:
1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.

2. NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
3. NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors for Commercial Cooking Equipment," Chapter 3, "Duct System," for kitchen hood duct systems, except as indicated otherwise.
- D. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Provide ductwork systems in conformance with "HVAC Duct Construction Standards – Metal and Flexible," latest edition.
- E. Underwriter's Laboratories (UL): Comply with the UL standards listed within this section. Provide mastic and tapes that are listed and labeled in accordance with UL 181A and marked according to type.
- F. National Air Duct Cleaners Association, Inc. (NADCA): Clean ductwork systems in accordance with the standard Assessment, Cleaning and Restoration of HVAC Systems (ACR 2002).

1.06 PROTECTION AND REPLACEMENT

- A. Protect ductwork during shipping and storage from dirt, debris and moisture damage. Provide plastic covers over ends of ductwork during shipping, storage and installation.
- B. Replace duct liner that is damaged and cannot be repaired satisfactorily. Replace duct liner that has gotten wet during shipping, storage or installation. Dry surfaces prior to installing new duct liner.

PART 2 - PRODUCTS AND MATERIALS

2.01 SHEET METAL MATERIALS

- A. Sheet Metal, General: Provide sheet metal in thickness indicated (minimum 24 gauge), packaged and marked as specified in ASTM A 700.
- B. Galvanized Sheet Steel: Lock-forming quality, ASTM A 653, Coating Designation G 90. Provide mill phosphatized or galvanealed finish for surfaces of ducts exposed to view that is to be field painted. Provide bright galvanized finish for ductwork that is exposed to view and not field painted.
- C. PVC-Coated Galvanized Steel: UL-181 Class 1 Listing. Lock-forming quality galvanized sheet steel with ASTM A 653, Coating Designation G 90. Provide with factory-applied, 4-mil, PVC coating on the exposed surfaces of ducts and fittings (exterior of ducts and fittings for underground applications, and the interior of ducts and fittings for fume-handing applications) and 2-mil PVC coating on the reverse side of the ducts and fittings.
- D. Carbon Steel Sheets: ASTM A 366, cold-rolled sheets, commercial quality, with oiled, exposed matte finish.
- E. Stainless Steel: ASTM A 480, Type 316, sheet form, with No. 4 finish on exposed surface for ducts exposed to view; Type 304, sheet form, with No. 1 finish for concealed ducts.
- F. Aluminum Sheets: ASTM B 209, Alloy 3003, Temper H14, sheet form; with standard, one-side bright finish where ducts are exposed to view, and mill finish for concealed ducts.
- G. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless steel ducts provide reinforcing of compatible materials.
- H. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.02 SEALING MATERIALS

- A. Joint and Seam Sealants, General: Duct tape shall not be used as a sealant on any ducts.
- B. Water-Based Joint and Seam Sealant, Non-Fibrated: UL 181 Listed and UL 723 classified with flame spread/smoke development of less than 25/50. Sealant shall be rated to ± 15 inches w.g. Sealant shall have a service temperature of -25 to 200 F and be freeze/thaw stable through 5 cycles. Approved products: Childers CP-146, Design Polymerics DP 1010, Ductmate Proseal/Fiberseal, Duro Dyne Duroseal, Fosters 32-19, United Duct Sealer (Water Based) and Hardcast 601.

2.03 FIRE-STOPPING

- A. Fire-Resistant Sealant: Provide two-part, foamed-in-place, fire-stopping silicone sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Fire-Resistant Sealant: Provide one-part elastomeric sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Products: Subject to compliance with requirements, provide one of the following:
 - 1. "3M Fire Stop Foam"; 3M Corp.
 - 2. "SPECSEAL Pensil 200 Silicone Foam"; Specify Technology, Inc.
 - 3. "3M Fire Stop Sealant"; 3M Corp.
 - 4. "3M Fire Barrier Caulk CP-25"; Electrical Products Div./3M.
 - 5. "Fyre Putty"; Standard Oil Engineered Materials Co.
 - 6. "FS-ONE", Hilti, Inc.

2.04 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.
- B. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.
 - 1. Hangers Installed In Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.
 - 2. Straps and Rod Sizes: Conform with SMACNA HVAC Duct Construction Standards, 2005 Edition, for sheet steel width and gauge and steel rod diameters.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.
 - 1. Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.
 - 2. For stainless steel ducts, provide stainless steel support materials.
 - 3. For aluminum ducts, provide aluminum support materials, except where materials are electrolytically separated from ductwork.

2.05 RECTANGULAR DUCT FABRICATION

- A. General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Tables 2-1 through 2-28, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.
 - 1. Fabricate rectangular ductwork of minimum 24 gauge sheet metal.
 - 2. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
 - 3. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
- B. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gauge or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 2-9, unless they are lined or are externally insulated.
- C. Exterior Ductwork: Ductwork installed exterior to the building without weather-proof jacket or cladding shall be minimum #18 gauge with longitudinal and transverse joints welded or sealed airtight as specified under Paragraph "Seam and Joint Sealing".
- D. Field Painted Ductwork: Provide mill phosphatized finish on exposed surfaces of rectangular ductwork and duct fittings to be field painted.

2.06 RECTANGULAR DUCT FITTINGS

- A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 2005 Edition, Figures 4-1 through 4-8. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual balancing damper, 3/8 inch square shaft, U-bolt, nylon bushings, locking quadrant, and 2 inch insulation build-out for branch duct connections and take-offs to individual diffusers, registers and grilles. 45 degree, high efficiency, rectangular/round branch duct takeoff fittings shall be Flexmaster STO with model BO3 damper or equal.
- B. Provide radius elbows, turns, and offsets with a minimum centerline radius of 1-1/2 times the duct width. Where space does not permit full radius elbows, provide short radius elbows with a minimum of two continuous splitter vanes. Vanes shall be the entire length of the bend.
- C. Provide mitered elbows where space does not permit radius elbows, where shown on the drawings, or at the option of the contractor with the engineer's approval. The contractor shall obtain approval to substitute mitered elbows in lieu of radius elbows prior to fitting fabrication. Mitered elbows less than 45 degrees shall not require turning vanes. Mitered elbows 45-degrees and greater shall have single thickness turning vanes of same material and gauge as ductwork, rigidly fastened with guide strips in ductwork. Vanes for mitered elbows shall be provided in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease ductwork. Refer to Section "Ductwork Accessories" for turning vane construction and mounting.
- D. Provide full radius elbows for ductwork installed in noise critical spaces. Refer to Section "Basic Mechanical Materials and Methods" for noise critical spaces. Where space does not permit the installation of radius elbows, provide mitered elbows with sound attenuating, acoustical turning vanes. Refer to Section "Ductwork Accessories" for acoustical turning vanes.

2.07 ROUND AND FLAT OVAL DUCT FABRICATION

- A. General: "Basic Round Diameter" as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given sized of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not less than 12 feet.
 - 1. Fabricate round and flat oval ductwork of minimum 24 gauge sheet metal.
- B. Round Ducts: Fabricate round supply ducts using seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-1, RL-4, or RL-5 except where diameters exceed 72 inches. Seam Types RL-2 or RL-3 may be used for ducts smaller than 72 inches in diameter if spot-welded on 1-inch intervals. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams. Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-5 through 3-13 for galvanized steel gauges. For round duct with static pressure classification of 2 inches water gauge or lower, round supply ducts may be fabricated using snaplock seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-6A, RL-6B, RL-7 or RL-8.
- C. Flat Oval Ducts: Fabricate flat oval supply ducts with standard spiral lockseams (without intermediate ribs) or with butt-welded longitudinal seams in gauges listed in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-15.
- D. Field Painted Ductwork: All round and flat oval ductwork and duct fittings to be field painted shall have galvanized metal primer applied in the shop after fabrication and prior to shipping.

2.08 ROUND AND FLAT OVAL SUPPLY AND EXHAUST FITTINGS FABRICATION

- A. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 3-5, 3-6 and 3-7 and with metal thickness specified for longitudinal seam straight duct.
- B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.
- C. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter. Provide full radius elbows for ductwork installed in noise critical spaces or where shown on the drawings. Refer to Section "Basic Mechanical Materials and Methods" for noise critical spaces. Where space limits the installation of full radius elbows, short radius elbows with a minimum of two continuous splitter vanes shall be installed. Vane length shall be the entire length of the bend or 36 inches whichever is greater. Unless elbow construction type is indicated, provide elbows meeting the following requirements:
 - 1. Mitered Elbows: Fabricate mitered elbows with welded construction in gauges specified below.
 - a. Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-1.
 - b. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:
 - 1) 3 to 26 inches: 24 gauge.
 - 2) 27 to 36 inches: 22 gauge.
 - 3) 37 to 50 inches: 20 gauge.
 - 4) 52 to 60 inches: 18 gauge.
 - 5) 62 to 84 inches: 16 gauge.

- c. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 2 inches to 10 inches:
 - 1) 3 to 14 inches: 24 gauge.
 - 2) 15 to 26 inches: 22 gauge.
 - 3) 27 to 50 inches: 20 gauge.
 - 4) 52 to 60 inches: 18 gauge.
 - 5) 62 to 84 inches: 16 gauge.
 - d. Flat Oval Mitered Elbows: Solid welded and with the same metal thickness as longitudinal seam flat oval duct.
 - e. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material handling classes A and B; and only where space restrictions do not permit the use of 1.5 bend radius elbows. Fabricate with a single-thickness turning vane.
- 2. Round Elbows - 8 Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.
 - 3. Round Elbows - 9 Through 14 Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.
 - 4. Round Elbows - Larger Than 14 Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.
 - 5. Die-Formed Elbows for Sizes Through 8 Inches and All Pressures: 20 gauge with 2-piece welded construction.
 - 6. Round Gored Elbows Gauges: Same as for non-elbow fittings specified above.
 - 7. Flat Oval Elbows Gauges: Same as longitudinal seam flat oval duct.
 - 8. Pleated Elbows Sizes Through 14 Inches and Pressures Through 10 Inches: 24 gauge.

2.09 FACTORY-MANUFACTURED DUCTWORK

- A. General: At the Contractor's option, factory-manufactured ductwork can be provided instead of fabricated ductwork for round and oval ductwork. All factory-manufactured round and oval supply, return and exhaust ductwork shall be Linx Industries, Inc Lindab Safe, Lewis & Lambert, Wesco or approved equal. The round duct system shall consist of fittings that are factory fitted with a sealing gasket and spiral duct which, when installed according to the manufacturer's instructions, will seal the duct joints without the use of duct sealer. The oval duct system shall be sealed with duct sealer as specified in this section.
- B. Duct Construction
 - 1. Unless otherwise noted, all duct and fittings shall be constructed from galvanized steel in accordance with SMACNA's Duct Construction Standards for +10" water gauge pressure with thickness as shown in the following tables:

Single Wall Round Duct:

Diameter (Inches)	Galvanized Spiral Duct	Galvanized Fittings
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3-14	24	24
15-24	24	24
26-42	24	22
42-60	22	20

Double Wall Round Duct:

Diameter (Inches)	Galvanized Spiral Duct		Galvanized Fittings	
	Inner	Outer	Inner	Outer
3-14	28	24	24	24
16-24	26	24	24	24
26-42	24	24	22	22
44-60	22	22	20	20

Oval Duct:

Major Axis (Inches)	Galvanized Spiral Duct (ga)	Galvanized Fittings (ga)
3-24	24	20
25-38	22	20
37-48	22	18
49-60	20	18
61-70	20	16
71 and large	18	16

- Duct shall be calibrated to manufacturer's published dimensional tolerance standard.
- All duct 14" diameter and larger shall be corrugated for added strength and rigidity.
- Spiral seam slippage shall be prevented by means of a flat seam and a mechanically formed indentation evenly spaced along the spiral seam.
- Ducts shall be constructed using spiral lock seam sheet metal construction.
- Ductwork to be installed in exposed locations shall have the surface prepared in the factory for field painting.

C. Fittings:

- All fitting ends for round duct and transitions and divided flow fittings smaller than 50" diameter that convert oval duct to round duct shall come factory equipped with a double lipped, U-profile, EPDM rubber gasket. Gasket shall be manufactured to gauge and flexibility so as to insure that system will meet all of the performance criteria set forth in the manufacturer's literature. Gasket shall be classified by Underwriter's Laboratories to conform to ASTM E84-91a and NFPA 90A flame spread and smoke developed ratings of 25/50.
- All fittings shall be calibrated to manufacturer's published dimensional tolerance standard and associated spiral duct.
- All fitting ends from 5" to 60" diameter shall have rolled over edges for added strength and rigidity.
- All elbows from 5" to 12" diameter shall be 2 piece die stamped and continuously stitch welded. All elbows 14" diameter and larger shall be standing seam gorelock construction and internally sealed.

5. The radius of all 90° and 45° elbows shall be 1.5 times the elbow diameter, unless otherwise noted on the contract documents to be 1.0. The radius of all 15°, 30° and 60° elbows shall be 1.0 times the elbow diameter.
6. All fittings that are of either spot welded or button punched construction shall be internally sealed. When contract documents require divided flow fittings, only full body fittings will be accepted. The use of duct taps is unacceptable except for retrofit installations.
7. Double wall duct and fittings shall consist of a perforated or solid inner liner, a 1 inch, 1.50 lb/ft³ (unless otherwise specified) layer of fiberglass insulation and a solid outer pressure shell. Perforated inner liner shall have a retaining fabric wrapped between the perforated inner and the fiberglass insulation. This fabric shall provide fiberglass tear retention while maintaining the desired acoustical properties. For 1 inch thick insulation, the outer pressure shell diameter shall be 2 inches larger than the inner liner.
8. All double wall fittings for round duct shall be furnished with the Lindab Safe gasket on the outer shell. The inner shell on all double wall fittings shall extend a minimum of 1 inch past the outer shell.
9. Double wall to single wall transitions shall be provided where insulated duct connects to non-insulated, single wall duct. Transitions shall also act as insulation ends reducing the double wall outer shell diameter to the inner shell diameter.
10. All double wall duct and fittings shall be furnished with both an inner liner and an outer pressure shell coupling. The inner liners shall not be fastened tighter to allow for expansion and contraction.
11. All volume dampers shall be Lindab Safe type DRU, DSU or DTU or approved equal. Damper shall be fitting sized to slip into spiral duct. Damper shall have the following features:
 - a. Locking quadrant with blade position indicator.
 - b. 2" sheet metal insulation stand-off.
 - c. Integral shaft/blade assembly.
 - d. Shaft mounted, load bearing bushings.
 - e. Gasketed shaft penetrations to minimize leakage.

PART 3 - EXECUTION

3.01 DUCT MATERIAL APPLICATION

- A. All ducts shall be galvanized steel except as follows:
 1. Grease Hood Exhaust Ducts: Comply with NFPA 96.
 - a. Concealed: Carbon-steel sheet, minimum 16 gauge.
 - b. Exposed: Type 304, stainless steel, minimum 18 gauge, with finish to match kitchen equipment and range hood.
 - c. Weld and flange seams and joints.
 - d. At Contractor's option, a UL listed concentric ductwork package may be used in lieu of the welded carbon steel duct for connecting hood to exhaust fan. Provide manufacturers UL listing number and verification certificate as a part of the shop drawing submittal. Install duct package in strict conformance with manufacturer's instructions and recommendations.

2. Dishwasher Hood Exhaust Ducts:
 - a. Dishwasher exhaust duct shall be continuously welded aluminum above the ceiling and welded stainless steel below the ceiling or continuously welded stainless steel.
 - b. Slope ductwork serving dishwasher hood to drain back to hood. Provide condensate drains as required to prevent the accumulation of water within ductwork.
3. Dryer Vent Ducts: Rigid, smooth wall, aluminum duct, minimum 24 gauge.
- 4.

3.02 DUCT INSTALLATION, GENERAL

- A. Duct System Pressure Class: Construct and install each duct system except factory-manufactured ductwork for the specific duct pressure classification indicated. For factory-manufactured ductwork, refer to Paragraph "Factory-Manufactured Ductwork".
 1. Supply Air Ducts: 3 inches water gauge.
 2. Primary Supply Air Ducts (upstream of terminal boxes): 4 inches water gauge.
 3. Secondary Supply Air Ducts (downstream of terminal boxes): 2 inches water gauge
 4. Return and Outdoor Air Ducts: 2 inches water gauge, negative pressure(3" pressure class for 100'from fan).
 5. Exhaust Air Ducts: 2 inches water gauge, negative pressure.
- B. Install ducts with the fewest possible joints.
- C. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.
- D. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.
- E. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Cover ducts openings during construction with duct caps or three-mil plastic to protect inside of (installed and delivered) ductwork from exposure to dust, dirt, paint and moisture. Do not use duct tape on ducts that will be exposed or painted.
- H. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.
- I. Install insulated ducts with 1-inch clearance outside of insulation.
- J. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.
- K. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- L. Exposed Ductwork: Exposed ductwork shall be free of defects, dents or blemished surfaces to provide a smooth, finished appearance. Any damaged material shall be replaced with new material. Ductwork that is to be field painted shall have surfaces wiped clean of lubricant, dirt, or fil prior to priming and painting. Apply primer and paint of type as recommended by paint manufacturer for duct material and finish.

- M. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- N. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1-1/2 inches.
- O. Acoustical Barrier Penetrations: Where a duct passes through a wall, ceiling or floor slab of a noise critical space, provide a clear annular space of 1-inch between the duct and the structure. Refer to Section "Common Work Results for HVAC" for noise critical spaces. The Contractor shall check the clearance and, if clearance is acceptable, shall install the duct and pack the voids full depth with mineral fiber batt insulation. Contractor shall caulk both ends with a non-aging, non-hardening sealant backed by a polyethylene foam rod or permanently flexible firestop material. Where there is insufficient clearance space, Contractor shall place a short stub duct in the wall, pack and caulk around it and then attach the inlet and outlet ducts to each end.

3.03 SEAM AND JOINT SEALING

- A. General: Seal duct seams and joints as follows:
 - 1. All ductwork, including supply, return and exhaust shall have circumferential joints, longitudinal joints, and duct wall penetrations externally sealed in accordance to SMACNA Class A. The sealant used to seal the longitudinal joints of low pressure ductwork must be visible or the joints shall require resealing in the field.
 - 2. Seal class shall apply to all supply, return, outdoor air, and exhaust ductwork, regardless if the duct is positively or negatively pressurized.
- B. Seal externally insulated ducts prior to insulation installation.
- C. Ductwork installed exterior to the building shall have longitudinal and transverse joints welded or sealed airtight with weatherproof heavy liquid sealant applied according to manufacturer's instructions.

3.04 HANGING AND SUPPORTING

- A. Install rigid round, rectangular, and flat oval metal duct with support systems indicated in Chapter 5 of the SMACNA "HVAC Duct Construction Standards", 2005 Edition.
- B. The use of wire rope hanging systems is an acceptable alternate hanging methods when installed in strict accordance with manufacturer's instructions. Wire rope hanger spacing shall not exceed 8 feet. Supported load shall not exceed manufacturer's recommended load rating.
- C. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.
- D. Support vertical ducts at a maximum interval of 16 feet and at each floor.
- E. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated. Hangers and supports shall be fastened to building joists or beams. Do not attach hangers and supports to the above floor slab or roof with sheet metal screws.
- F. Install concrete insert prior to placing concrete.
- G. Install powder actuated concrete fasteners after concrete is placed and completely cured.

3.05 PENETRATIONS

- A. Fire Barrier Penetrations: Where ducts pass through fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity.

- B. Exterior Wall Penetrations: Seal duct penetrations through exterior wall constructions with sleeves, packing, and sealant. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for additional information.
- C. Underground Exterior Wall Penetrations: Seal duct penetrations through underground exterior walls with sleeves, packing, and sealant. Refer to Division 23 Section "Basic Piping Materials and Methods" for additional information.
- D. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of No-Fire Rated Walls and Concrete Slab on Grade Penetrations: Seal ducts that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for special sealers and materials.

3.06 CONNECTIONS

- A. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 23 Section "Air Duct Accessories."
- B. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 4-5 and 4-6.
- C. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 7-6 and 7-7. Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor's option, a flexible elbow assembly as specified in Division 23 Section "Air Duct Accessories."
- D. Fan Connections: Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 7-8.

3.07 FIELD QUALITY CONTROL

- A. Refer to Paragraph "Field Constructed Mock-Ups" in Part 1 for duct systems to be leak tested.
- B. The Owner will contract with an independent testing agency to perform, record, and report leakage tests.
- C. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.
- D. All duct shall be cleaned and capped prior to installing and installed duct shall not have the ends uncapped to prevent the entry of dust during construction.

3.08 FIELD QUALITY CONTROL

- A. Duct Leakage Testing:
 - 1. Perform leak testing for all ductwork with a pressure classification of 2" and above, ductwork with a cross-sectional area greater than 6 square feet, and all ductwork enclosed in shafts.
 - 2. Leak test at least 50% of the low pressure supply, and 50% of the return and exhaust ductwork to ensure duct tightness and air handler system performance. Leak test the supply duct from the AHU to the terminal boxes. Leak test return and exhaust duct that is the equivalent of 8 inches in diameter and larger. Leak test all duct that is an enclosed in a chase or above a drywall ceiling.
 - 3. Follow procedure published by United Sheet Metal Division of United McGill Corporation entitled "System Pressure Testing for Leaks" using prescribed test kit containing test blower, two U-tube manometer, and calibrated orifice tube. Orifice flow measurement device to be individually calibrated against a primary standard and a calibrated curve permanently attached to orifice tube assembly.
 - 4. If system is tested in sections, leakage rates may be totaled to give performance of the whole system.

5. All leak testing is to be witnessed by General Contractor's Quality Control on-site representative. Require the General Contractor to maintain, on-site, a set of ductwork prints that are shaded in different colors to show the duct sections isolated for each test. Specify that the General Contractor shall also indicate on the print, the date each section of duct was tested and the final percent leakage rate measured for each test section.
 6. The final duct leakage test report is to be submitted to the Commissioning Authority.
 7. For low pressure ductwork, where both longitudinal and transverse seams are fully sealed, leakage test described herein may be omitted.
- B. Grease Duct Leakage Test: All portions of grease duct systems shall be tested for leakage in accordance with Chapter 5, Section 506 of the locally adopted IMC. Leakage tests shall be by light or other equivalent test methods as approved by the local code official to verify that all joints are liquid tight. Tests shall be performed in the presence of the local code official. Any joints found defective shall be repaired and retested until satisfactory results are obtained. The contractor shall submit a copy of the grease duct leakage test report to the Architect and Engineer complete with the approval signature of the local code official.
- C. Smoke Control Duct Leakage Test: All portions of smoke control duct systems shall be tested for leakage in accordance with Chapter 5, Section 513 of the locally adopted IMC. Ducts shall be leak tested to 1.5 times the maximum design pressure. Measured leakage shall not exceed 5 percent of design air flow. Test shall be as approved by the local code official to verify that all joints are liquid tight. Tests shall be performed in the presence of the local code official. Any joints found defective shall be repaired and retested until satisfactory results are obtained. The contractor shall submit a copy of the smoke control duct leakage test report to the Architect and Engineer complete with the approval signature of the local code official.

3.09 ADJUSTING AND CLEANING

- A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Refer to Division 23 Section "TESTING, ADJUSTING, AND BALANCING FOR HVAC" for requirements and procedures for adjusting and balancing air systems.

END OF SECTION 23 31 13

SECTION 23 33 00 AIR DUCT ACCESSORIES

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this Section.
- B. Types of ductwork accessories required for project include the following:
 - 1. Dampers.
 - a. Low pressure manual dampers.
 - b. Counterbalanced backdraft dampers.
 - 2. Electronic zone pulse damper systems.
 - 3. Turning vanes.
 - 4. Duct hardware.
 - 5. Duct access doors.
 - 6. Flexible ductwork.
 - 7. Flexible elbow assembly.
 - 8. Metal duct connectors.
 - 9. Flexible duct connectors.
- C. Refer to other Division 23 Sections for testing, adjusting, and balancing of ductwork accessories; not work of this Section.

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of ductwork accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Codes and Standards:
 - 1. SMACNA Compliance: Comply with applicable portions of SMACNA "HVAC Duct Construction Standards, Metal and Flexible", 2005 Edition.
 - 2. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.
 - 3. UL Compliance:
 - a. Construct, test, and label fire dampers in accordance with current edition of UL Standard 555 "Fire Dampers". Construct, test, and label smoke dampers in accordance with current edition of UL Standard 555S "Smoke Dampers".
 - b. Construct flexible ductwork in compliance with UL Standard 181 "Factory-Made Air Ducts and Connections".
 - c. Duct tape shall be labeled in accordance with UL Standard 181B and marked 181B-FX. Non-metallic duct clamps shall be labeled in accordance with UL Standard 181B and marked 181B-C.
 - d. Duct clamps shall be labeled in accordance with UL Standard 181B and marked 181B-C.
 - e. Grease exhaust duct wrap shall meet the fire protection requirements defined by UL Standard 1479 "Fire Tests of Through-Penetration Firestops".
 - f. Fire rated duct wrap shall meet the fire protection requirements defined by UL Standard 1479 "Fire Tests of Through-Penetration Firestops".
 - 4. NFPA Compliance:

- a. Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories. Comply with NFPA 90B "Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - b. Comply with NFPA 96 "Ventilation Control and Fire Protection of Commercial Cooking Operations" for fire-rated grease exhaust ducts.
5. ASTM Compliance: Products shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 "Surface Burning Characteristics" (NFPA 255) method.
- a. Duct silencers shall be tested for performance in accordance with ASTM E477 "Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers."
 - b. Grease exhaust duct wrap shall be tested for performance in accordance with ASTM E 2336 "Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems" and ASTM E814 "Standard Test Methods of Fire Resistance of Through-Penetration Fire Stops".
 - c. Fire rated duct wrap shall be tested in accordance with ASTM E814 "Standard Test Methods of Fire Resistance of Through-Penetration Fire Stops".

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory including dimensions, capacities and materials of construction; and installation instructions. Submit performance data for duct silencers including insertion loss performance in octave bands from 63 Hz to 8,000 Hz and pressure drop at specified airflow.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.
- C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.04 SPARE PARTS

- A. Furnish extra fusible links to Owner, one link for every 10 installed of each temperature range; obtain receipt.

PART 2 - PRODUCTS AND MATERIALS

2.01 DAMPERS

- A. Low Pressure Manual Dampers: Provide dampers of single blade type or multi-blade type, constructed in accordance with SMACNA "HVAC Duct Construction Standards". Damper material shall be galvanized steel for standard air systems, aluminum for wet or natatorium environments and stainless steel for corrosive environments. Bearings shall be corrosion resistant, molded synthetic and axles shall positively lock into the damper blade. Extended shafts shall be metal material. Blade seals shall be neoprene for round dampers. Blade seals shall be silicone for rectangular dampers. Dampers shall be Greenheck Model MBD Series, or approved equal, with locking quadrant. Provide with standoff bracket and shaft extension as required for insulation requirements.
- B. Control Dampers: Refer to Division 23 section Instrumentation and Control Devices for HVAC for control dampers; not work of this section.
- C. Counterbalanced Backdraft Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to open at indicated static pressure. Construct frames and blades of minimum 16-ga aluminum. Provide minimum 1/2" diameter, corrosion-resistant bearings and 1/2" diameter, galvanized or stainless steel axles. Blade edge seals shall be mechanically locked

into blade edge. Blade seals shall be neoprene for round dampers. Blade seals shall be silicone or vinyl for rectangular dampers.

- D. Manufacturer: Subject to compliance with requirements, provide dampers of one of the following:
1. Air Balance, Inc.
 2. Arrow United Industries.
 3. Cesco
 4. Greenheck
 5. Louvers & Dampers, Inc.
 6. Nailor Industries, Inc.
 7. Pottorff
 8. Ruskin Mfg. Co.
 9. TAMCO
 10. Vent Products

2.02 CABLE OPERATED DAMPER SYSTEMS

- A. General: Where access to dampers through a hard ceiling is required, provide a concealed, cable operated volume damper with remote operator.
1. Damper shall be adjustable through the diffuser face or frame with standard 1/4" nutdriver or flat screwdriver.
 2. Cable assembly shall attach to damper as one piece with no linkage adjustment.
 3. Positive, direct, two-way damper control shall be provided with no sleeves, springs or screw adjustments to come loose after installation.
 4. Provide cable length as required to span the distance from the damper to the remote operator location.
 5. Support cable assembly to avoid bends and kinks in cable.
- B. Manufacturer: Subject to compliance with requirements, provide cable operated damper systems of one of the following:
1. Metropolitan Air Technology, Inc. (Reference model number is RT-250).
 2. Young Regulator Co..

2.03 TURNING VANES

- A. Manufactured Turning Vanes: Provide turning vanes and runners fabricated from galvanized sheet metal, lock-forming quality, ASTM A 653, minimum Coating Designation G 60, of the same gauge thickness or greater as the ductwork in which they are installed. Vanes shall be rigidly fastened with guide strips to minimize noise and vibration. Vanes in ductwork over 30" deep shall be installed in multiple sections with vanes not over 30" long and shall be rigidly fastened. Turning vanes shall be constructed per SMACNA Duct Construction Standards Metal and Flexible – 2005 Edition, Figure 4-3 and set into side strips suitable for mounting in ductwork.
- B. Acoustical Turning Vanes: Provide acoustical turning vanes constructed of airfoil shaped aluminum extrusion with perforated faces and fiberglass fill in systems serving noise critical spaces. Refer to Section "Common Work Results for HVAC".
- C. Manufacturer: Subject to compliance with requirements, provide turning vanes of one of the following:
1. Aero Dyne Co.
 2. Anemostat Products Div.; Dynamics Corp. of America.
 3. Ductmate Industries.
 4. Duro Dyne Corp.
 5. Elgen Manufacturing Co., Inc.

6. Hart & Cooley Mfg. Co.
7. Register & Grille Mfg. Co., Inc.
8. Sheet Metal Connectors, Inc.

2.04 DUCT HARDWARE

- A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:
 1. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.
 2. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.
- B. Manufacturer: Subject to compliance with requirements, provide duct hardware of one of the following:
 1. Ductmate Industries.
 2. Elgen Manufacturing Co., Inc.
 3. Ventfabrics, Inc.
 4. Young Regulator Co.

2.05 DUCT ACCESS DOORS

- A. General: Provide, where indicated on the drawings or where specified in Part 3 of this section, duct access doors of size allowable by duct dimensions with, unless otherwise noted on the drawings, minimum size of 10" by 10" and maximum size of 24" by 24". Provide removable section of duct where duct size is too small for a 10" by 10" access door. Construct access doors in accordance with SMACNA "HVAC Duct Construction Standards – Metal and Flexible" and as specified herein. Label access doors for fire and smoke dampers as specified in Paragraph "Installation of Ductwork Accessories.
- B. Construction: Construct of same or greater gage as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one size hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors.
- C. Manufacturer: Subject to compliance with requirements, provide duct access doors of one of the following:
 1. Air Balance Inc.
 2. Ductmate Industries.
 3. Duro Dyne Corp.
 4. Register & Grille Mfg. Co., Inc.
 5. Ruskin Mfg. Co.
 6. Ventifabrics, Inc.
 7. Vent Products.
 8. Zurn Industries, Inc.; Air Systems Div.

2.06 FLEXIBLE DUCT.

- A. Construction: Provide flexible ductwork conforming to UL 181-Class I, NFPA 90A and NFPA 90B and as follows. Duct types of manufacturers are indicated for reference in regards to required quality of construction and materials. Flexible duct shall have fire retardant polyethylene or reinforced metalized protective vapor barrier as follows:
 1. Low pressure (duct pressure class up to and including 2" w.g.) and medium pressure (duct pressure class greater than 2" up to and including 6" w.g.)
 - a. Fire retardant polyethylene vapor barrier
 - 1) ATCO 80 Series

- 2) Flexmaster Type 5B
 - 3) JPL Type PR Series
 - 4) Thermaflex Type G-KM
 - b. Reinforced metalized vapor barrier
 - 1) ATCO 30 Series
 - 2) Flexmaster Type 5M
 - 3) JPL Type MHP Series
 - 4) Thermaflex Type M-KE
2. High pressure (duct pressure class over 6" w.g.)
 - a. Fire retardant polyethylene vapor barrier
 - 1) Flexmaster Type 3B
 - b. Reinforced metalized vapor barrier
 - 1) Flexmaster Type 3M
 - 2) Thermaflex Type M-KC
3. Flexible ductwork shall have CPE liner with steel wire helix mechanically locked or permanently bonded to the liner.
4. Provide acoustical, fiberglass insulated duct with minimum R-value of [R-4.2][R-5.0][R-6.0][R-8.0].
- B. Manufacturer: Subject to compliance with requirements, provide flexible ductwork of one of the following:
 1. ATCO Rubber Products.
 2. Flexmaster.
 3. JPL (J.P. Lamborn Co)
 4. Thermaflex.

2.07 FLEXIBLE ELBOW ASSEMBLY

- A. General: At Contractors option, in lieu of rigid sheet metal elbows at connections to air inlets and outlets in concealed spaces, provide flexible elbow assembly to air devices requiring a 90 degree elbow connection.
- B. Flexible elbow assembly shall be constructed of durable composite material and UL listed for use in return air plenums with a turning radius of not less than 3 inches.
- C. Flexible elbow assembly shall be FlexFlow Elbow as manufactured by Flexible Technologies, Inc., FlexRight Elbow as manufactured by Build Right Products or approved equal.

2.08 METAL DUCT CONNECTORS

- A. Description: Factory-fabricated, slide-on transverse flange connectors, corners, cleats, gaskets, and components. Material, gauge, and shape shall match the connecting ductwork.
- B. Manufacturers: Subject to compliance with requirements, provide duct connectors by one of the following or approved equal:
 1. Ductmate Industries.
 2. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

2.09 FLEXIBLE DUCT CONNECTORS

- A. General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibration of connected equipment.
- B. Fabric Material: Flame-retardant or noncombustible fabrics compliant with NFPA 701.

1. Metal-Edged Connectors: Factory fabricated with a fabric strip minimum 3-1/2 inches wide attached to two strips of minimum 24 gauge galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
2. Indoor System, Flexible Connector Fabric: Glass fabric coated with neoprene.
 - a. Minimum Weight: 26 oz./sq. yd.
 - b. Minimum Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - c. Service Temperature: Minus 40 to plus 200 deg F.
3. Outdoor System, Flexible Connector Fabric: Glass fabric coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - a. Minimum Weight: 24 oz./sq. yd.
 - b. Minimum Tensile Strength: 225 lbf/inch in the warp and 300 lbf/inch in the filling.
 - c. Service Temperature: Minus 40 to plus 250 deg F.
4. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
 - a. Minimum Weight: 16 oz./sq. yd.
 - b. Minimum Tensile Strength: 200 lbf/inch in the warp and 150 lbf/inch in the filling.
 - c. Service Temperature: Minus 65 to plus 500 deg F.
5. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
 - a. Minimum Weight: 14 oz./sq. yd.
 - b. Minimum Tensile Strength: 400 lbf/inch in the warp and 300 lbf/inch in the filling.
 - c. Service Temperature: Minus 67 to plus 500 deg F.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Flexible connectors shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.
- E. Manufacturer: Subject to compliance with requirements, provide flexible connections of one of the following:
 1. Ductmate Industries.
 2. Duro Dyne Corp.
 3. Elgen Manufacturing Co., Inc.
 4. Ventfabrics, Inc.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Install [backdraft] [control] dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- C. Provide balancing dampers at branch takeoffs from main ducts. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual balancing damper and locking quadrant for branch duct connections and take-offs to individual diffusers, registers and grilles.

- D. Coordinate all smoke and fire/smoke damper installation, wiring, and checkout to ensure that the dampers function properly and that they respond to the proper fire alarm system signal.
- E. Install ceiling radiation dampers per manufacturer's instructions. Support damper assembly from structure.
- F. Provide turning vanes, of same gauge as ductwork, rigidly fastened with guide strips in ductwork having an offset of 45 degrees or more. Vanes shall be provided in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease ductwork.
- G. Provide duct access doors to maintain and/or clean components internal to ductwork including, but not limited to, coils, airflow stations, motorized and backdraft dampers, humidifiers, etc, and equipment at the following locations: Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
 - 1. At each change in direction and at maximum 50-foot (15-m) spacing.
 - 2. Upstream [and downstream] from turning vanes.
 - 3. Upstream or downstream from duct silencers.
- H. Provide duct access door(s) as scheduled below, at each fire and smoke damper within 12 inches of the device to allow for testing and maintenance. Label each door (with minimum 1" lettering) indicating which damper type is served. Door should be capable of being fully opened or provide removable door.

DUCT ACCESS DOOR SCHEDULE

Duct Width/Depth	Door Size	Quantity
10" TO 12"	10 X 10	1
14" TO 18"	12 X 12	1
20" TO 36"	14 X 14	1
38" TO 54"	18 X 18	1
56" TO 72"	18 X 18	2 (1 EACH END)
74" TO 96"	20 X 20	2 (1 EACH END)

- I. Install flexible duct in accordance with manufacturer's instructions. At a minimum, install two wraps of duct tape around the inner core connection and a metallic or non-metallic clamp over the tape and two wraps of duct tape or a clamp over the outer jacket.
 - 1. Flexible duct runs shall not exceed 5 feet in length. Utilize the minimum length of duct to make the connections.
 - 2. Flexible ductwork shall be installed straight as possible avoiding tight turns with a maximum of one 90 degree bend in any length. Install flexible duct fully extended minimizing compression.
 - 3. Provide continuous length with no intermediate joints.
 - 4. Support flexible duct from structure and not from ceiling tile, light fixtures or air terminals. Support for maximum sag of 1/2-inch per foot.
 - 5. Avoid incidental contact with metal fixtures, water lines, pipes, or conduit.
 - 6. Support straps/saddles shall be minimum 1-1/4" wide. Use of wire hanging systems shall utilize strap and connect wire to strap.
 - a. Factory installed suspension systems are acceptable
 - 7. Ductwork shall not be crimped against joist or truss members, pipes, conduits, etc.
 - 8. The bend radius at the center line shall be equal to or greater than one duct diameter.
 - a. Support bends approximately one duct diameter on both sides of bends.
 - 9. Connections to ductwork and air devices shall have at least 1" overlap.
- J. Provide rigid duct elbow or flexible elbow assembly where a 90 degree elbow is required at connection to air devices.

- K. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.03 FIELD QUALITY CONTROL

- A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

3.04 ADJUSTING AND CLEANING

- A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.
- B. Label access doors in accordance with Division-23 section "Identification for HVAC Piping and Equipment".
- C. Final positioning of manual dampers is specified in Division-23 section "Testing, Adjusting, and Balancing for HVAC".
- D. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 33 00

SECTION 23 34 23 HVAC POWER VENTILATORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Inline centrifugal fans.

1.02 REFERENCE STANDARDS

- A. AMCA 99 – Standards Handbook.
- B. AMCA 204 – Balance Quality and Vibration Levels for Fans.
- C. AMCA 210 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
- D. AMCA 300 – Reverberant Room method for Sound Testing of Fans.
- E. AMCA 301 – Certified Ratings Program Product Rating manual for Fan Sound Performance.
- F. AMCA 311 – Certified Ratings Program Product Rating Manual for Fan Sound Performance.
- G. NFPA 96 – Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- H. UL 705 – Power Ventilators; Current Edition Including all Revisions.
- I. UL 762 – Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances; Current Edition Including all Revisions.

1.03 SUBMITTALS

- A. General: Submit data in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements. Include the following:
 - 1. For fans with factory-furnished starters or variable frequency drives, include short circuit current ratings.
 - 2. Materials gages and finishes, including color charts.
 - 3. Dampers, including housings, linkages, and operators.
- C. Shop Drawings: Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.
- D. Wiring Diagrams: Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.
- E. Maintenance Data: Include instructions for lubrication, motor and drive replacement and spare parts list.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Fan Belts: One set for each individual fan.

1.04 QUALITY ASSURANCE

- A. AMCA Compliance: Provide products that meet AMCA certified performance and sound ratings and are licensed to use the AMCA Seal.
- B. UL Compliance: Fans and fan motors shall be designed, manufactured, and tested in accordance with UL 705 "Power Ventilators."
- C. Kitchen Hood Exhaust Fans: Kitchen hood exhaust fans and components shall comply with requirements of UL 762 and NFPA 96.
- D. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.
- E. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- F. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

1.06 FIELD CONDITIONS

- A. Permanent fans may not be used for ventilation during construction.

PART 2 - PRODUCTS AND MATERIALS

2.01 POWER VENTILATORS - GENERAL

- A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished; with indicated capacities and characteristics.
- B. Statically and Dynamically Balanced: Fans and shafts shall be statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.
 - 1. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.
- C. Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210.
- D. Sound Ratings: Comply with AMCA 301. Test fans in accordance with AMCA Standard 300.
- E. Fabrication: Comply with AMCA 99.
- F. Motors: Refer to Section "Common Motor Requirements for HVAC Equipment" for requirements.
- G. Motor and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions.
 - 1. Belt Guards: Provide steel belt guards for motors mounted on the outside of the fan cabinet.
- H. Hazardous Duty: Provide fans with spark resistant construction and explosion proof motor where specified in the schedule.
- I. Factory Finish: The following finishes are required:

1. Sheet Metal Parts: Prime coating prior to final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.

2.02 UPBLAST ROOF EXHAUSTERS

A. Manufacturers:

1. Accurex.
2. Acme Engrg. & Mfg. Corp.
3. Carnes Company, Inc.
4. Cook (Loren) Co.
5. Greenheck Fan Corp.
6. Hartzell Fan, Inc.
7. PennBarry.
8. RuppAir Management Systems
9. Twin City Fan Company

B. General Description: Belt-driven or direct-drive as indicated, consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

C. Fan Wheel:

1. Type: Non-overloading centrifugal, propeller or axial blades as scheduled
2. Material: Aluminum ,

D. Housing:

1. Construct of heavy-gage aluminum including curb cap, windband and motor compartment..
2. Rigid internal support structure.
3. One-piece fabricated or fully welded curb-cap to windband for leak proof construction.
4. Wind Band and Base: Reinforced and braced aluminum, containing aluminum butterfly dampers and rain trough, motor and drive assembly, and fan wheel.
 - a. Dampers Rods: Steel with bronze or nylon bearings.
5. Provide breather tube for fresh air motor cooling and wiring.

E. Shafts and Bearings:

1. Fan Shaft:
 - a. Ground and polished steel with anti-corrosive coating.
 - b. First critical speed at least 25 percent over maximum cataloged operating speed.
2. Bearings
 - a. Permanently sealed or pillow block type.
 - b. Minimum L10 life in excess of 50,000 hours.

F. Drive Assembly: Resiliently mounted to the housing, with the following features:

1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
2. Belts: Static free and oil resistant.

- 3. Pulleys: Cast-iron, adjustable-pitch, keyed and securely attached to the wheel and motor shafts..
- G. Roof Curbs: Refer to Section "Hangers and Supports for HVAC" for pre-engineered roof equipment supports.
- H. Drain Trough: Provides single point drainage for water or other residue.
- I. Accessories: Provide the following items as indicated:
 - 1. Disconnect Switch: Nonfusible type, with thermal overload protection mounted inside fan housing, factory-wired through an internal aluminum conduit.
 - 2. Bird Screens: Maximum 1/2-inch mesh, 16-gage aluminum or brass wire.
 - 3. Dampers: Counter-balanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - 4. Dampers: Motor-operated, parallel-blade, volume control dampers mounted in curb base.
 - a. Blades: Die-formed sheet aluminum.
 - b. Frame: Extruded aluminum, with waterproof, felt blade bumpers.
 - c. Linkage: Nonferrous metals.
 - d. Operators: Manufacturer's standard electric motoractuator.
 - e. Operators: Manufacturer's standard pneumatic motoractuator.

PART 3 - EXECUTION

3.01 SEQUENCING AND SCHEDULING

- A. Coordinate the size and location of structural steel support members.

3.02 INSTALLATION

- A. Install fans level and plumb, in accordance with manufacturer's written instructions.
- B. Secure roof-mounted fans to pre-engineered roof equipment supports in accordance with the requirements specified in Section "Hangers and Supports for HVAC Piping and Equipment."
- C. Cabinet Units: Suspend units from structural steel support frame using steel wire or metal straps.
- D. Install vibration isolation for equipment as specified in Division 23 Section "Vibration Isolation for HVAC Piping and Equipment."
- E. Arrange installation to provide access space around fans for service and maintenance.

3.03 ADJUSTING, CLEANING, AND PROTECTING

- A. Adjust damper linkages for proper damper operation.
- B. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.04 STARTUP

- A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
 - 1. Remove shipping blocking and bracing.

2. Verify fan assembly is secure on mountings and supporting devices and that connections for ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
 3. Perform cleaning and adjusting specified in this Section.
 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 6. Verify manual and automatic volume control and that fire and smoke dampers in connected ductwork systems are in the full-open position.
 7. Disable automatic temperature control operators.
- B. Starting procedures for fans:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
 - a. Replace fan and motor pulleys as required to achieve design conditions.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Shut unit down and reconnect automatic temperature control operators.
 4. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for air-handling-system testing, adjusting, and balancing.

3.05 DEMONSTRATION

- A. Demonstration Services: Train Owner's maintenance personnel on the following:
1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
 2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section "Closeout Procedures" and Division 23 Section "General Mechanical Requirements."
- B. Schedule training with at least 7 days' advance notice.

END OF SECTION 23 34 23

SECTION 23 36 00 AIR TERMINAL UNITS

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. Extent of air terminals work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of air terminals specified in this section include the following:
 - 1. Variable Air Volume Terminal Units
 - a. Shutoff Single Duct
 - b. Reheat

1.02 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. ADC Compliance: Provide air terminals which have been tested and rated in accordance with ADC standards, and bear ADC Seal.
 - 2. AHRI Compliance: Provide air terminals which have been tested and rated in accordance with AHRI 880 "Industry Standard for Air Terminals" and bear AHRI certification seal.
 - 3. NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A "Air Conditioning and Ventilating Systems".
 - 4. UL/ETL Compliance: Air terminal units shall be UL or ETL listed as a complete assembly. All electrical components shall be UL listed and installed in accordance with the National Electric Code.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including performance data for each size and type of air terminal furnished; certified sound power data for each unit; schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished; and installation and start-up instructions.
- B. Nameplate Data: Nameplate data shall be submitted in a timely manner so as to allow proper coordination with the Electrical Contractor. Submittals that do not have nameplate data will be rejected.
- C. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- D. Wiring Diagrams: Submit ladder-type wiring diagrams for electric power and control components, clearly indicating required field electrical connections.
- E. Maintenance Data: Submit maintenance data and parts list for each type of air terminal; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and maintenance data in maintenance manual; in accordance with requirements of Division 1.

1.04 SPARE PARTS

- A. If HVAC equipment is used during construction, the contractor is fully responsible for it's cleaning just before substantial completion prior to testing and balancing.

PART 2 - PRODUCTS AND MATERIALS

2.01 VARIABLE AIR VOLUME TERMINAL UNITS

- A. General: Provide factory-fabricated and tested air terminals as indicated, selected with performance characteristics which match or exceed those indicated on schedule.
- B. Acceptable Manufacturers: Subject to compliance with requirements, provide air terminals of one of the following:
 - 1. Johnson Controls, Inc (VRU).
 - a. Contact: Kevin Tolbert
 - b. email: kevin.p.tolbert@jci.com
 - c. 478-952-8740
 - 2. Siemens Industry Inc.
 - a. Contact: Edward Tambornino
 - b. email: ed.tambornino@siemens.com
 - c. 847-271-8136
- C. Casings: Construct of galvanized sheet metal of minimum 22 gauge thickness or die-cast aluminum of minimum 20 gauge thickness.
 - 1. Provide hanger brackets for attachment of supports.
 - 2. Linings: Line inside surfaces of casings with lining material to provide acoustic performance, thermal insulation, and to prevent condensation on outside surfaces of casing. Provide minimum thickness of 1/2". Lining shall be closed cell foam and comply with UL 181 and NFPA 90A. Insulation shall be 1-1/2 lb. density.
 - 3. Access: Provide removable panels in casings to permit access to air dampers, fans and other parts requiring service, adjusting, or maintenance.
 - a. Provide airtight gasket and quarter-turn latches.
 - 4. Leakage: Construct casings such that when subjected to 0.5-in w.g. pressure for low pressure units, and 3.0-in w.g. pressure for high pressure units, total leakage does not exceed 2% of specified air flow capacity with outlets sealed and inlets wide open. Construct air dampers such that when subjected to 6.0-in w.g. inlet pressure with damper closed, total leakage does not exceed 5% of specified air flow capacity.
- D. Air Dampers: Construct of materials that cannot corrode, do not require lubrication, nor require periodic servicing. Provide maximum volume dampers that are calibrated in cfm, factory-adjusted, and marked for specified air capacities. Provide mechanism to vary air volume thru damper for minimum to maximum, in response from signal from thermostat.
- E. Controls: Provide controls accurate to 1.5 degrees F and adjustable from 65 degrees F to 85 degrees F. Provide air flow measurement station at terminal unit inlet. Provide control type as indicated below.
 - 1. Provide direct digital controls, compatible with direct digital control system specified in other Division 23 sections.
- F. Identification: Provide label on each unit indicating Plan Number, cfm range, cfm factory-setting, and calibration curve (if required).
- G. Heating Coils: Provide the following features as indicated on Drawings and schedule:

1. Hot Water Heating Coils: Provide heating coils constructed of copper tubes and aluminum fins with galvanized steel casing.
2. Hot water coils shall be factory installed with a maximum of ten (10) aluminum fins per inch and rated in accordance with ARI 410. The coil circuiting shall be a multi circuited header with corrosion free brass manual air vent piped in at the highest and lowest point of the piping header to ensure efficient drainage and air removal from the coil. A metal coil-u-bend cover shall to be factory installed on the coil u-bends to protect the coil u-bends during shipment and installation. Upstream and downstream coil casing connections to terminal unit and duct extension to be sealed with silver foil tape rated at 6" TSP. Tube thickness shall be a minimum of 0.016"
3. Braided stainless steel hose kits are acceptable for terminal boxes. Hoses to be a minimum of 3/4" diameter and 24" long and to have operating temperature range from -40° to 250° Fahrenheit, a working pressure of 400 psi, and a minimum burst pressure of 1600 psi. . Hose kits to ship with one end attached to the VRU piping valve assembly and the other end with a minimum 3/4" diameter 8 " long sealed copper air chamber. The sealed end of the copper air chamber should be cut, prepped and connected to the loop piping. Do not twist the hose kit during installation and keep all flux and other chemicals off the braided hoses. Pay close attention during construction to allowable hose bend radius.
4. VAV boxes serving operating rooms and C-section rooms shall have a minimum of two-rows for rapid room warm-up. Heating coils in all other VAV terminal units shall be selected to maintain a minimum space temperature of 75°F with 140°F hot water supply temperature. Two-row coils are preferred in all applications to reduce fan power requirements and sound transmission.
5. Two (2) 90 degree copper pipes formed on a tube bender shall be sweated directly to the header of the coil with a minimum distance of 6 inches from the coil inlet and to the coil outlet regardless of the coil size. Sweated copper elbows and fittings are not acceptable to achieve the same result.
6. Terminal box assembly shall consist of factory fabricated terminal unit, integral controls, coil, piping of the sizes, capacities and configurations shown on the drawings with catalogued part numbers. All controls and hydronics piping shall be accessible from the same side of the unit. All hydronics piping packages shall be piped in the opposite direction of the control panel, downstream of the VAV terminal unit. Controls Contractor shall be responsible for proper selection/sizing of the VAV based on scheduled performance parameters and the supplying of the VAV.
7. The piping assembly and coil shall be field reversible. The hydronics piping structure and 2 handle shipping brackets shall be attached to the coil inlet and outlet connections as one assembly integral to the VAV. All piping assemblies for the VAVs supplied shall be identical and interchangeable for inlet sizes of four (4) inch through 24 inch. The supply and return aspect ratios of the inlet and outlet piping shall be 6 inch on center of the coils. The piping aspect ratio is identical for all VAVs supplied regardless of VAV box/coil size.
8. The following minimum factory installed piping components shall be supplied; a valve package consisting of a stainless steel ball valve with a #20 stainless steel screen to act as a strainer, a union, P/T (pressure temperature) port, drain or blow-down with integrated stainless ball valve and removable brass end cap to seal the drain connection. Union with P/T port. All P/T ports require an extension of a minimum of 1.5 inches. Stainless steel isolation valve, union, and P/T readout ports. Pressure gauge to confirm 100% leak free product delivery. Type "L" 3/4 inch copper pipe. Two (2) 24 inch long stainless steel hose kits tested to meet UL94 with a VO rating and a washer-less design with a 6" long 3/4:" sealed copper air chamber attached to each end of the hose.

9. Memory stops shall not be provided with VAV boxes, but shall be available from the manufacturer for field retrofit without the need to replace the entire valve, should the need arise.
 10. A ½ inch control valve with stainless steel ball and stem shall be provided and factory installed in the piping trim at the factory. A 24 volt electric non-spring return modulating valve actuator shall be provided. The actuator wires shall be terminated to the VMA controller. Both the actuator and control valve shall be tested before leaving the factory.
 11. The entire VAV assembly (terminal unit, coil, hydronics piping packages, controls hardware, electrical components and wiring) shall be seismically certified per IBC 2010 code with a 2.5 allowance factor and carry the OSHPD (OSP) certification.
 12. If required for single-side access, single duct terminal units with hot water coils shall be shipped with a factory supplied 16 inch duct extension attached downstream of the coil. The construction of the duct extension shall be equal to the quality of materials and workmanship to that of the terminal unit. All connections to be sealed with silver foil tape rated at 6" of total pressure. The insulation shall match the insulation of the VAV box.
- H. A control panel manufactured with a minimum 20 gauge sheet metal shall be supplied. The enclosure cover design shall allow for the following motions with a single universal design: a 180 degree hinged motion, a sliding motion from left to right and right to left including full removal of the enclosure cover without tools. The controls cover shall reside in a set position without the use of mechanical fasteners or screws. "Quick Release" sheet metal tabs/guide stops shall be supplied to allow the cover from slipping off when in the fully open position. The "Quick Release" tabs/guide stops shall be designed in such a way to allow the complete removal of the cover. A handle shall be supplied on the controls cover for opening and closing the controls cover. The control enclosure shall have factory installed knock outs for mounting all the electrical and controls components required. All electrical and electronic components including both line voltage and low voltage shall be mounted in the metal controls enclosure per applicable codes. The control panel shall include stand-offs to allow mounting of the controls and electrical items without penetrating the VAV terminal box casing.
- I. A transformer with primary and secondary transformer fusing with a toggle disconnect switch shall be provided and installed at the factory. All secondary wiring from the toggle switch and transformer to the VMA vav controller shall be factory installed and tested before shipment.
- J. A platinum 1k ohm DAT (Discharge Air Temperature) Sensor shall be provided. The DAT sensor shall have a stainless steel mounting flange with two hex-head self-drilling mounting screws and come equipped with a 10 ft plenum rated cable with ¼" female insulated quick-connect terminator leads. Cable must meet UL 1995 requirements for installation within an air plenum. The DAT sensor shall be factory installed in the duct extension at the farthest point downstream of the coil. The DAT sensor shall be factory checked for proper resistance range and factory-wired to the VMA- 1630 controller.
- K. A VAV box controller shall be provided and factory installed. All wiring from the DAT, transformer and control valve shall be connected and tested at the factory. The pneumatic tubes from the air flow sensor shall be connected to the controller transducer at the factory
- L. A minimum of two adjustable Universal Handle Brackets with built in handles shall be supplied for every VAV furnished. Handles shall be constructed with a minimum of 14 gauge metal shall be painted to avoid corrosion and stress fractures of hydronics. Handle opening shall be able to accept a minimum of the following lifting devices through the handle portion of the bracket without damaging the product: human hand, forklift, Unistrut, pipe or other lifting devices. The handle shall have a 180 degree – "rolled up edge" to prevent injury to the human hand: raw edges or non-rolled edges shall not be accepted.

- M. The shipping handle brackets shall use 4 military grade rubber grommets for elimination of galvanic corrosion and isolation between copper piping and support handles. The rubber grommets shall be made of Buna-N and be resistant to petroleum-based oils and fuels, water and alcohols.
- N. Four aircraft cables shall be factory installed on the VAV with the job specific platform fastening mechanism at the end of the aircraft cables. Cables shall be a minimum of 10 feet long. Cables shall be rated for a minimum of 100 lbs each with a 5:1 safe working load allowance.
- O. All sound data shall be compiled in an independent ADC certified laboratory and in accordance with the latest version of AHRI 880. All units shall be AHRI certified and bear the AHRI certification label.

PART 3 - QUALITY ASSURANCE

- A. The hydronics piping structure and coil shall be charged with nitrogen or other appropriate dry gas at the factory before shipment at greater than sea level pressure at the assembly area; seal the gas in the piping structure: Test the sealed piping structure and coil for a minimum of 12 hours to determine whether the gas stays within the hydronics Piping Structure and coil through the use of a pressure gauge. If the gas leaks from the hydronics piping structure per the pressure gauge identify the leak, fix it and re-test upon verification of the piping structure having zero leakage of the gas prior to shipment.
- B. Transport the sealed and pressurized piping structure with coil from the factory to the construction site; determining a pressure of the gas at the construction site. If hydronics structure and coil arrives without holding pressure, then Contractor to trouble shoot and fix leak.
- C. Inside of terminal unit and duct extension to be cleaned and wiped down. Inlet and discharge shall be wrapped with a protective cover. All VAVs shall be individually tagged, strapped down, palletized, enclosed in cardboard boxes and shrink wrapped with a pallet stretch machine. Labels with bar codes shall be adhered to the to each unit with the following information: Tag numbers, Model no, Serial no., Date of manufacture, Manufacturer, Inlet size, MFG, ID # and Job Name. Electrical wiring schematic shall be adhered to the outside of each control enclosure. Additional tagging to be placed on the outside of the cardboard box shrink wrapping. Shipping boxes shall list all relative shipping information including reference ID no., telephone number and name of person/entity receiving the product(s), and tags of individual VAV units on the pallets
- D. Inlet of terminal unit and outlet of duct extension to be sealed with a plastic wrap to keep air borne particles out of the inlet and outlet of the VAV. In addition, the entire assembly shall be wrapped and secured to the shipping pallet.
- E. Factory Commissioning of Controls and Software
 - 1. Load appropriate VAV program into the DDC controller and program all the performance parameters commensurate for each zone/VAV unit per schedule supplied by the controls contractor
 - 2. Properly address each controller with the correct address in order for the BAS system to identify each DDC controller.
 - 3. Power up the VAV and run the program through full cycle operation. Stroke the damper actuator to full open and then to closed position. Stroke the temperature control valve to full open and full closed.
 - 4. Set and Ship all actuators in the open position
- F. Digital Data Retrieval System – VAV manufacturer shall provide the following as part of the Operational and maintenance manuals in digital form:

1. Digital images of each individual VAV shipped including the hydronic piping packages, controls hardware, electrical, coil and terminal unit taken before shipment.
2. Controller software and individual VAV performance files specific for each VAV by tag number.
3. Approved Submittals
4. Operational and maintenance instructions
5. Drawings
6. Part numbers

PART 4 - EXECUTION

4.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. The HCA standard is that heating coils on VAV boxes are not provided with individual balancing valves. Balancing valves are instead to be provided at every floor, wing, and at every branch serving a minimum of 3 VAV boxes. Confirm balancing of individual terminal box is not included in the base scope of work of the Test and Balancing agent.
- C. Provide shutoff valves as required for maintenance and replacement without a large-scale shutdown of equipment.
- D. The mechanical contractor is to provide and install a set of isolation valves at the connection of the hot water distribution piping and the braided steel hoses so the boxes can be isolated from the rest of the system in the event of a hose failure.

4.02 FIELD QUALITY CONTROL

- A. Upon completion of installation and prior to initial operation, test and demonstrate that air terminals, and duct connections to air terminals, are leak-tight.
- B. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

4.03 ADJUSTING AND CLEANING

- A. Adjust damper linkages for proper damper operation.
- B. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

END OF SECTION 23 36 00

SECTION 23 37 13

DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this Section.
- B. Types of outlets and inlets required for project include the following:
 - 1. Ceiling air diffusers.
 - 2. Wall registers and grilles.
- C. Refer to other Division 23 sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this Section.
- D. Refer to other Division 23 sections for balancing of air outlets and inlets; not work of this Section.

1.02 RELATED REQUIREMENTS

- A. 230548 – Seismic Controls for Mechanical Systems, for seismic controls.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. AHRI Compliance: Test and rate air outlets and inlets in accordance with AHRI 650 "Standard for Air Outlets and Inlets".
 - 2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
 - 3. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".
 - 4. ADC Seal: Provide air outlets and inlets bearing ADC Certified Rating Seal.
 - 5. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutters".
 - 6. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.
 - 7. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:
 - 1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
 - 2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
 - 3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings at specified airflows. Indicate selections on data.
 - 4. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.
 - 5. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

- B. Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of diffusers, registers, and grilles with other items installed in ceilings and walls.
- C. Color Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for diffusers, registers, and grilles with factory-applied color finishes.
- D. Samples for Verification: Provide samples of diffusers, registers, and grilles, in manufacturer's standard sizes, showing the full range of colors. Prepare Samples from the same material to be used for the Work.

1.05 SPARE PARTS

- A. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

PART 2 - PRODUCTS AND MATERIALS

2.01 CEILING AIR DIFFUSERS

- A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.
- B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.
- D. Linear Slot Diffusers: Slot diffusers shall be standard one-piece lengths up to 6-feet and shall be furnished in multiple sections greater than 6-feet. Multiple sections shall be joined together end-to-end with alignment pins to form a continuous slot appearance. All alignment components shall be provided by the manufacturer. Plenums shall be manufactured by the slot diffuser manufacturer. Plenums shall be internally insulated, by the manufacturer, with minimum 1/4" thick, closed-cell insulation. Insulation shall not be made of fibrous material.
- E. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as scheduled on the drawings.
- F. Manufacturers: Subject to compliance with requirements, provide diffusers of one of the following:
 - 1. Carnes Co.
 - 2. Price Industries, Inc.
 - 3. Krueger Mfg. Co.
 - 4. Metalaire; Metal Industries, Inc.
 - 5. Nailor Industries, Inc.
 - 6. Titus HVAC
 - 7. Tuttle & Bailey; Div. of Air Systems Components, Inc.

2.02 REGISTERS AND GRILLES

- A. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.
- B. Performance: Provide wall registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.

- C. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.
- D. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as scheduled on the drawings.
- E. Manufacturers: Subject to compliance with requirements, provide registers and grilles of one of the following:
 - 1. Carnes Co.
 - 2. Price Industries, Inc.
 - 3. Krueger Mfg. Co.
 - 4. Metalaire; Metal Industries, Inc.
 - 5. Nailor Industries, Inc.
 - 6. Titus HVAC
 - 7. Tuttle & Bailey; Div. of Air Systems Components, Inc.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which air outlets and inlets are to be installed for compliance with installation tolerances and conditions that would affect the performance of the equipment. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install air outlets and inlets in accordance with manufacturer's written instructions, design drawings, referenced standards, and in accordance with recognized industry practices to insure that products serve intended function.
- B. Coordinate with other work, including ductwork and duct accessories, to interface installation of air outlets and inlets with other work.
- C. Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor's option, a flexible elbow assembly as specified in Division 23 section "Metal Ducts".
- D. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.

3.03 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before beginning air balance.

3.04 CLEANING

- A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove dirt and smudges. Replace any air device that has damaged finishes.

END OF SECTION 23 37 13

SECTION 23 73 13

OUTDOOR CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes constant and variable volume, central-station air-handling units with coils for indoor installations.

1.02 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
1. Product data for each central-station air-handling unit indicated, including the following:
 - a. Certified fan performance curves with system operating conditions indicated.
 - b. TMA asset tracking
 - c. Report unweighted octave band AHU sound power for inlets and outlets rated in accordance with AHRI Standard 260. Provide eight data points, the first for the octave centered at 63 Hz, and the eighth centered at 8,000 Hz. Manufacturer shall not use sound estimates based on bare fan data (AMCA ratings), nor use calculations like the substitution method based on AHRI 260 tests of other AHU products. Provide data for inlets and outlets as scheduled. Report unweighted casing radiated sound power over the same 8 octave bands in accordance with ISO 9614 Parts 1&2 and ANSI S12.12.
 - d. Certified coil performance ratings with system operating conditions indicated.
 - e. Motor ratings and electrical characteristics plus motor and fan accessories.
 - f. Provide short circuit current rating of units with factory mounted starter or variable frequency drive.
 - g. Materials, gages and finishes.
 - h. Filters with performance characteristics.
 - i. Dampers, including housings, linkages, and operators.
 - j. Airflow measuring device performance shall be certified and rated in accordance with AMCA-611. Report data in accordance with AMCA-611. Provide AMCA Certified Rating Seal for Airflow Measurement Performance.
 - k. Report panel deflection at +/-8" w.g., stated in terms of 'L/X' where 'L' is the casing panel length and 'X' is a constant provided by the AHU manufacturer.
 - l. Report casing leakage rate at +/-8" w.g., specified in terms of percentage of design airflow.
 - m. Report weight loads and distributions by component section.
 - n. Report product data for filter media, filter performance data, filter assembly, and filter frames.
 2. Shop drawings from manufacturer detailing dimensions, weights, required clearances, components, and location and size of each field connection.
 3. Adjust and report performance ratings for the proper altitude of operation.
 4. Wiring diagrams detailing wiring for power and controls and differentiating between manufacturer-installed wiring and field-installed wiring.
 5. Product certificates signed by manufacturers of central-station air-handling units certifying that their products comply with specified requirements.
 6. Maintenance data and recommended spare parts list for central-station air-handling units for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 23 Section "General Mechanical Requirements."

1.03 QUALITY ASSURANCE

- A. NFPA Compliance: Central-station air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA Standard 90A "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. UL Compliance: Electric coils, along with the complete central-station air-handling unit, shall be listed and labeled by Underwriters' Laboratories.
- C. Nationally Recognized Tested Laboratory and NEMA Compliance (NRTL): Electric coils, along with the complete central-station air-handling unit shall be listed and labeled by a NRTL. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.
- D. AHRI Certification: Central-station air-handling units and their components shall be factory tested in accordance with the applicable portions of AHRI 430 - Standard for Central-Station Air-Handling Units and shall be listed and bear the label of the Air-Conditioning and Refrigeration Institute.
- E. Air Handling Unit safety: ETL or UL 1995
- F. Air Handling Unit energy use: ASHRAE 90.1
- G. Fans: AMCA 210
- H. Air Coils: AHRI 410
- I. Air Handling Unit certification program: ANSI/AHRI 430
- J. Filter media: ANSI/UL 900 listed Class I or Class II
- K. Control wiring: NEC codes & ETL requirements
- L. Motors: Federally mandated Energy Policy Act (EPACT).
- M. Airflow Monitoring Stations: AMCA 611-95
- N. Units shall be seismically certified in accordance with applicable IBC 2000, 2003, 2006, 2009 or 2012 and applicable Building Code for life safety environments.
- O. Manufacturer shall have a minimum of 25 years of experience in designing, manufacturing, and servicing air-handling units.
- P. The design indicated on the schedules and shown on the drawings is based upon the products of the named manufacturer.

1.04 COORDINATION

- A. If equipment is supplied other than as shown on plans, coordinate with the General Contractor and affected subcontractors. This coordination shall include (but is not limited to) the following:
 - 1. Structural supports for units.
 - 2. Size and location of concrete bases/housekeeping pads
 - 3. Location of roof curbs, unit supports and roof penetrations
 - 4. Ductwork sizes and connection locations
 - 5. Piping size and connection/header locations
 - 6. Interference with existing or planned ductwork, piping and wiring
 - 7. Electrical power requirements and wire/conduit and over current protection sizes.
 - 8. Trap height requirements
- B. The Mechanical Contractor shall be responsible for costs incurred by the General Contractor, Subcontractors, and Consulting Engineers to accommodate units furnished other than as shown as basis of design.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Comply with ASHRAE 62, Section 5 (mold and corrosion resistant casings, filters upstream of wetted surfaces, and drain pan design).

- B. Comply with ASHRAE 62, Section 7 (practices to be followed during construction and startup). Protect equipment from moisture by appropriate in-transit and on-site procedures.
- C. Follow manufacturer's recommendations for handling, unloading and storage.
- D. Protect, pack, and secure loose-shipped items within the air-handling units. Include detailed packing list of loose-shipped items, including illustrations and instructions for application.
- E. Protect, pack and secure controls devices, motor control devices and other electronic equipment. Do not store electronic equipment in wet or damp areas even when they are sealed and secured.
- F. Enclose and protect control panels, electronic or pneumatic devices, and variable frequency drives. Do not store equipment in wet or damp areas even when they are sealed and secured.
- G. Seal openings to protect against damage during shipping, handling and storage.
- H. Wrap indoor and outdoor units with a tight sealing membrane. Wrapping membrane shall cover entire AHU during shipping and storage. Cover equipment, regardless of size or shape. Alternatively AHU must be tarped for shipment and storage.
- I. Wrap equipment, including electrical components, for protection against rain, snow, wind, dirt, sun fading, road salt/chemicals, rust and corrosion. Keep equipment clean and dry.
- J. Clearly mark AHU sections with unit tag number, segment sequence number, and direction of airflow. Securely affix safety-warning labels.

1.06 SPARE PARTS

- A. General: Furnish to Owner, with receipt, the following spare parts for each air-handling unit.
 - 1. One set of spare filters of each type required for each unit. Obtain receipt from Owner that spare filters have been provided. In addition to the spare set of filters, install new filters at completion of installation work, and prior to testing, adjusting, and balancing work.
 - 2. If HVAC equipment is used during the construction period, Contractor shall provide one set of filters (if system is designed to include pre-filters and after-filters, provide only pre-filters) when the unit is started and replace filters when needed, but not less than every month. On the day of substantial completion, the Contractor shall clean the unit and provide a new set of filters at each location in the unit.
 - 3. In addition to the set of filters provided with the air handler, provide one clean set for balancing, and one additional set for final turnover to owner, for a total of 3 sets of filters provided.
 - 4. Furnish one additional complete set of belts for each central-station air-handling unit.
 - 5. Furnish one additional gasket for each sectional joint of each central-station air-handling unit.

1.07 WARRANTY

- A. Provide entire unit parts and labor warranty for 12 months from date of substantial completion. Warranty shall cover manufacturer defects. Warranty work shall be performed by manufacturer's factory-trained and factory-employed technician.
- B. For air handlers provided with UV lights, include service contract to replace bulbs once per year for five years after startup. Contract must include materials and labor to install new and dispose of old bulbs.
- C. Parts associated with routine maintenance, such as belts and air filters shall be excluded.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule as YORK, div. of Johnson Controls Inc.

2.02 MANUFACTURED UNITS

- A. The owner requirement is for modular type air handlers where possible. Custom type equipment is only to be applied where absolutely necessary.
- B. Air Handling Unit (AHU) consists of a structural base, insulated casing, access doors, fans, motors, motor controls, coils, filters, dampers, components, and accessories; as shown on drawings, schedules, and specifications.
- C. Provide AHU to meet the specified levels of performance for scheduled items including airflow, static pressure, cooling capacity, heating capacity, electrical characteristics, sound, casing leakage, panel deflection and casing thermal performance.
- D. Provide internal components and accessories as specified and scheduled. Components and accessories shall be installed by the AHU manufacturer.
- E. Ship units in one piece. Split units only where necessary for shipping and installation.
- F. Manufacturer shall provide detailed, step-by-step instructions for disassembly and reassembly.
- G. For AHU segments that must be broken down for rigging and installation: segment shall be disassembled and reassembled by manufacturer's factory-trained service personnel.

2.03 STANDARDS COMPLIANCE

- A. Comply with ratings and certifications referenced in this specification.
- B. Manufacturers who do not comply with ANSI/AHRI-430 shall factory test EACH unit to verify brake horsepower rating, airflow performance and total static pressure performance.
- C. Manufacturers who do not conform to requirements of AHRI 260 for ducted discharge and return air sound shall submit EACH unit to an independent sound test laboratory for AHRI 260 testing. The test laboratory shall conform to AHRI 260, Section 4.4, Test Equipment and Facilities.

2.04 BASE RAIL

- A. Provide a structural base rail under the full perimeter of the unit
- B. Provide clearance for proper external trapping of drain pans without the need to cut the floor.
- C. Provide base rail and lifting lug system that does not require additional support for rigging. Include base rail lifting lugs at unit corners.

2.05 CABINET

- A. Provide 2" double wall AHU casing. Exposed insulation is not acceptable.
- B. Panel assembly shall meet UL standard 1995 for fire safety. Panel insulation shall comply with the requirements of NFPA 90A.
- C. Provide an insulation system that is resistant to mold growth in accordance with a standardized test method such as UL 181 or ASTM C 1338.
- D. Encapsulate insulation with sheet metal so that air does not contact insulation. Solid lined panels insulated with spray injected foam shall be hermetically sealed at each corner and around their entire perimeter, to eliminate airflow through the panel and to eliminate microbial growth potential within the casing wall. Foam insulation shall fully fill entire floor, all walls, and roof with no voids.
- E. Provide casing with minimum thermal resistance (R-value) of 13 hr-ft²-°F/BTU for indoor applications and 16 hr-ft²-°F/BTU for outdoor. The casing shall incorporate thermal breaks as required so that when assembled, minimal path(s) of continuous unbroken metal to metal conduction from inner to outer surfaces exist.
- F. All exterior (minimum 18 gauge) and interior (minimum 20 gauge) casing panels (roof, wall, access door) shall be made of G90 galvanized steel. Interior casing panels (walls and floor) shall be made of 304 stainless steel within wet sections – from cooling coil or humidifier up to supply fan bulkhead. Units installed within 60 miles of the coast shall also include 304 stainless steel walls in outdoor air sections up to the cooling coil.
- G. Floors shall be provided with 0.125" aluminum diamond tread plate liner for units 48" and greater in height. Units below 48" in height shall have 14 gauge G90 galvanized steel floors in dry

sections and 14 gauge 304 stainless steel floors from cooling coil or humidifier to fan bulkhead. Units shorter than 48" installed within 60 miles of the coast shall also have 14 gauge 304 stainless steel floors in outdoor air sections up to the cooling coil.

- H. Provide a unit frame of galvanized steel that provides the overall structure of the unit and does not rely on the casing panels for structural integrity.
- I. Unit shall conform to ASHRAE Standard 111 Class 6 for casing leakage no more than 1.0% of design airflow at 1.25 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections. The unit leakage is the sum of the leakage in all positively and negatively pressurized sections of the air handler.
- J. Provide wall panels and access doors that deflect no more than L/240 when subjected to 1.5 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint.
- K. Provide floors and roofs that deflect no more than L/240 when subjected to a 300 lb static load at mid-span. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint.
- L. Provide outdoor AHUs with a roof system that deflects no more than L/240 when subjected to a static snow load of 30 lb/ft². 'L' is defined as the panel-span length and 'L/240' is the deflection at the panel midpoint.
- M. Provide outdoor AHUs with a roof sloped at a minimum pitch of 1/4" per foot. The roof shall overhang side and end panels by a minimum of 2."
- N. Provide an exterior finish for outdoor AHUs that show a breakdown of less than 1/8" on either side of a scribed line when subjected to ASTM B117 500 hour, 5% salt spray conditions. This is equivalent to an ASTM D1654 rating of '6.'

2.06 PRIMARY DRAIN PANS

- A. Panel assembly shall meet UL standard 1995 for fire safety. Panel insulation shall comply with the requirements of NFPA 90A.
- B. Provide an insulation system that is resistant to mold growth in accordance with a standardized test method such as UL 181 or ASTM C 1338.
- C. Provide floors that deflect no more than L/240 when subjected to a 300 lb load at mid-span. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint
- D. Comply with the stated intent of ASHRAE Standard 62.
- E. Provide a drain pan under each cooling coil and humidifier. Drain pans for cooling coils and humidifiers shall meet the requirements of ASHRAE 62.
- F. Drain pans shall be stainless steel.
- G. Provide drain connection made of same material as drain pan. Do not use dissimilar metals because of the risk of galvanic corrosion. Weld connection to the drain pan.
- H. Cooling coil drain pan shall be double wall construction with an insulation R-value of 13 hr-ft²-°F/ (BTU-in). Low temp glycol coils shall be provided with additional 2" insulated drain pan subfloor. Drain pans shall be extended as much as possible without making the section longer.
- I. Provide drain pan under the complete width and length of cooling coil and humidifier sections. Drain pan shall be full width, and completely extend to next section downstream of cooling coil and humidifier within AHU without growing section length. Pan shall extend a minimum of 12" downstream of cooling coil except where the length is limited due to the installation of UV lighting.
- J. Drain pan shall allow visual inspection and physical cleaning on 100% of the pan surface without removal of the coil or humidifier.
- K. Provide a minimum of 1" clearance between the drain pan and any coil casing, coil support or any other obstruction.
- L. Provide drain pan that allows the design rate of condensate drainage regardless of fan status.

- M. Provide drain pan sloped in at least two planes by at least 1/8" per foot toward a single drain. Locate drain connection at the lowest point of the pan. Pan shall have no horizontal surfaces.

2.07 ACCESS DOORS

- A. Provide thermal break, double wall access door(s) that meet requirements for the AHU casing.
- B. Provide industrial-style stainless steel hinges that permit 180 degrees of door swing.
- C. Provide latches with roller cam mechanisms that ensure a tight seal. Rotating knife-edge or "paw" latches are not acceptable.
- D. Provide each door with a single handle linked to multiple latching points or a separate handle for each latching point. Doors serving access segments shall have an interior latch handle.
- E. Provide access doors with a locking hasp to accommodate a lockout device.
- F. Where permitted by code, provide double-pane viewing windows in all fan access sections, humidifier sections and upstream of all filter sections. Windows shall be a non-condensing type consisting of a desiccant dehumidification layer. Minimum dimension shall be 8" x 8".
- G. Provide VentLok 699 Test Port and gasket in all door systems and as needed to provide at least one port upstream and one port downstream of every coil and filter.
- H. Access doors, where permitted by code, are always to open against positive pressure.

2.08 ROOF CURBS

- A. Provide insulated factory-fabricated galvanized steel roof curb for outdoor units in accordance with local codes and seismic compliance. Roof curb shall support the full-perimeter of the air handling equipment, including pipe chases.
- B. Match roof curb to roof slope. Curb surface shall be level in both axes.
- C. Provide wood nailing strip to which roofer may nail roof flashing.
- D. Ship roof curb loose for field installation prior to unit placement.

2.09 FANS SECTION

- A. Direct drive fans are preferred over belt drive. As much as is practical, provide a minimum of two fans for all air handlers serving critical care or otherwise patient-facing areas. Evaluate the life cycle cost before specifying fan arrays with more than two fans.
- B. Provide, at a minimum, two single width, single inlet (SWSI) plenum fans with 1800 or 1200 RPM motors for units above 12,000 CFM. For units below 12,000 CFM, 3600 RPM fan arrays may be used unless two 2400 RPM fans can meet the capacity.
- C. Eighty hertz is the maximum allowed at design conditions unless approved by FacilitiGroup Engineer.
- D. Unless prohibited by code, fans shall not be selected for operation within 85% of MAX Fan RPM and BHP is not to be within 85% of motor nameplate HP. Fan selections shall incorporate a total final filter pressure drop of 1.5" w.c. and a total pre-filter pressure drop of .85" w.c. along with all inlet and discharge opening static pressure drops at design CFM.
- E. Maximum motor HP shall be 30 HP.
- F. Airfoil fans shall comply with AMCA standard 99 2408 69 and 99 2401 82. Provide an AMCA seal on airfoil fans. Airfoil fan performance shall be based on tests made in accordance with AMCA standards 210 and comply with the requirements of the AMCA certified ratings program for air performance.
- G. Provide fans with true airfoil blades unless otherwise scheduled.
- H. Provide fans with the following accessories:
 - 1. Fan inlet screens
 - 2. OSHA-compliant belt guard enclosing the fan motor and drive (if belt driven)
- I. Provide airfoil fans with blades formed of extruded aluminum, as scheduled. Bent sheet metal blades are not acceptable.

- J. Provide fans with polished steel shafts with first critical shaft speed at least 125% of the maximum operating speed for the fan pressure class. Shaft shall have an anti-corrosion coating.
- K. Mount the fan and motor assembly on a common adjustable base. This common base shall attach to vibration isolators, which mount to structural support channels. These channels shall span the AHU floor and mount directly to the AHU frame.
- L. Provide adequate vibration isolation with seismic snubbers.
- M. Provide horizontal thrust restraints between AHU casing and fan housings.
- N. Multiple Fans (Array of Direct-Drive Plenum Fans) shall be Model MPQ centrifugal plenum type, as manufactured by Twin City Fan & Blower, or Model HPA, manufactured by Greenheck.
 - 1. Performance — Fans shall conform to AMCA test standards, 205 (fan efficiency grade), 210 (air performance) and 300 (sound performance) and shall bear the AMCA certified ratings seal for both sound and air, and fan efficiency grade (FEG). Sound certification shall apply to both inlet and outlet sound power levels.
 - 2. Construction — Fans shall be housed and incorporate a non-overloading type backward inclined airfoil blade wheel, heavy-gauge galvanized G90 steel frame, and front panel. The front panel shall have a removable inlet cone designed for smooth airflow transition into the wheel. The motor base shall be designed to ensure proper alignment of the fan wheel, motor and inlet cone. The design shall also ensure the structural integrity of the base to minimize vibration.
 - 3. Wheel — Wheels shall be constructed of non-overloading extruded airfoil shaped blades. Airfoil blades shall be continuously welded. The entire wheel shall be constructed of aluminum to reduce weight and vibration. Blades shall be extruded aluminum. Wheel hubs shall be machined aluminum. Aluminum fan wheels shall not require a finish coating. Wheels shall be attached to the motor shaft using taper lock bushings. The wheel and fan inlet shall be matched and have precise running tolerances for maximum performance and operating efficiency.
 - 4. Finish and Coating — Fans shall be constructed of corrosion resistant galvanized steel. Aluminum components shall be unpainted.
 - 5. Motors — Motors shall meet or exceed EISA 2007 (The Energy Independence and Security ACT of 2007) efficiencies. Motors shall be NEMA rated, 720, 900 1200, 1800 or 3600 RPM in 60 Hz, Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (TEFC) with a 1.15 service factor.
 - 6. Fan Balancing — All fans prior to shipment shall be run tested at the specified operating speed. Each fan shall be dynamically balanced as a complete unit in accordance with ANSI/AMCA 204-96 "Balance Quality and Vibration Levels for Fans" to a minimum Fan Application Category BV-3, Balance Quality Grade G6.3. Balance readings shall be taken electronically in the axial, vertical and horizontal directions. Records of each fan balance shall be maintained and a written copy shall be available upon request.
 - 7. Blank off Panels — Each Multiple Fan section to be provided with fan blank-off panels to enable manual isolation of fan for servicing. Quantity of panels shall equal number of fans on a single VFD. Backdraft dampers (barometric or controlled) shall not be permitted.
 - 8. Fan Options — The following options shall be available for multiple fans:
 - a. Piezometer Ring: Rings shall be factory installed in each fan inlet. The device shall have a measurement accuracy of $\pm 5\%$. Tubing shall be field installed along with corresponding air flow monitoring station by DDC controls contractor so that the measurement is representative of all fans in the array.
- O. Fan Array Motor Control (common VFD operation with Array split into two banks)
 - 1. All fan motors shall be factory-wired to individual manual motor protection (MMP) device which shall consist of a motor overload relay with adjustable current rating and an on-off disconnect switch (one per motor) for power isolation. Field wiring of MMPs to fan motors shall not be permitted.

2. MMPs shall be contained in a single control panel (MMP panel) and shall be mounted on the exterior wall panel of the fan array section.
3. MMP panel shall have a single point of connection for input power wiring and shall feed power individual MMP's through a common bus bar. Independent wiring of input power to individual MMP's shall not be permitted.
4. All VFDs shall be operated together from a single control point so that all fan motors operate together. Independent control of VFDs and fan motors shall not be permitted.

2.10 BEARINGS AND DRIVES

- A. Provide bearings complying with ANSI/AFBMA 9 for fatigue life ratings.
- B. Provide fan bearings with an average life L10 of at least 200,000 hours, as scheduled.
- C. Provide re-greaseable bearings with hydraulic grease fittings and lube lines extended to the motor side of the fan.
- D. Provide direct-drive plenum fans.

2.11 MOTORS

- A. Provide fan motors built in accordance with the latest standards of the NEMA and IEEE.
- B. Provide AHU and fan motors in compliance with ASHRAE 90.1.
- C. Provide fan motors with the following characteristics:
 1. Voltage, Frequency and Phase, as scheduled.
 2. Motor RPM, as scheduled
 3. Minimum service factor of 1.15
 4. Premium efficiency, or as required to meet ASHRAE 90.1
 5. NEMA design ball bearing type
 6. Rated for continuous duty at full load in a 104°F (40°C) ambient
 7. Open drip proof (ODP) or totally enclosed, fan cooled (TEFC) as scheduled.
 8. Suitable for use in variable frequency application, per NEMA MG-1 Part 30
 9. Shaft Grounding Rings
 10. Premium Efficiency Inverter ready per NEMA STD MG1 PART 31.4.4.2
- D. Where practical, provide electronically commutated motors for fractional horsepower applications.

2.12 FAN-MOTOR VARIABLE FREQUENCY DRIVES (VFDS)

- A. Variable Frequency Drives shall be provided as follows:
 1. Dual Fans: One (1) VFD per fan motor with fused main disconnects.
 2. Fan Arrays: One (1) VFD with motor protection panel per half of fan array with fused main disconnects.
- B. Provide UL or ETL listed VFDs and associated components, as scheduled and shown on drawings. VFDs shall comply with applicable provisions of the National Electric Code.
- C. Mount VFDs in a dedicated NEMA 1 compartment located on the primary access side of its associated fan section and wire VFD to motor, unless otherwise indicated on drawings.
- D. Enclose outdoor VFDs in a NEMA 3R enclosure suitable for use in ambient temperatures from -20°F to 135°F:
- E. After unit installation, VFD shall be started and programmed by a factory trained and employed service technician. Refer to Section Part 3 - Execution 3.5.
- F. Refer to 26 29 23 for complete requirements for VFDs.
- G. Drives are to be provided without bypass, except in the case of a single-fan application.

2.13 FACTORY INSTALLED ELECTRICAL ACCESSORIES

- A. In addition to motor power terminals, provide an independent power terminal for convenience receptacles and lights. Provide switches as shown on drawings.
- B. Provide LED (light emitting diode) lights in segments as scheduled or shown on drawings. Provide light switches as scheduled or shown on drawings. Lights shall be constructed of safety glass and suitable for wet locations.
- C. Provide a 1-hour timer on external light switches.
- D. Provide a 20A 120V convenience receptacle on supply fan segment. Receptacle shall be powered separately from fan VFD so it remains energized when fan disconnect is open.
- E. Disconnects and VFDs are to be installed as close as practical to the fan motor they serve. Where factory-mounted disconnects are to be provided on stacked units, they are to be installed such that they can be reached by a service technician standing beside the unit without the use of a ladder.
- F. Where maintenance platforms are anticipated for ease of access to the upper level, disconnects are to be installed adjacent to, and on the same level as, the access door to the motor it serves.

2.14 COILS

- A. Provide coils manufactured by AHU manufacturer, except where noted in contract documents.
- B. Coils shall meet or exceed performance scheduled on drawings.
 - 1. When applicable, provide coils with performance certified in accordance with AHRI Standard 410 for coil capacity and pressure drop. Circuit coils such that the fluid velocity is within the range of certified rating conditions at design flow.
- C. Provide cooling coils with a maximum face velocity of 450 FPM. Face velocity calculations shall be based on the finned area of the coil. Manufacturer shall guarantee zero carryover at 500 fpm.
- D. Coils shall be provided with minimum 304 stainless steel coil casing with 304 stainless steel drain pan support structure. Heating coils shall be provided with G-90 galvanized steel coil casings except in the following situations:
 - 1. Heating coils in the preheat position in AHUs installed within 60 miles of the coast, and
 - 2. Heating coils for all AHUs installed in the reheat position.
- E. Cooling coils shall be a maximum of 8 rows and 10 fins per inch. In ASHRAE Climate Zones 1, 2, and 3, coils shall be 8 rows deep. No exceptions. Size cooling coils for minimum 80/67 EAT unless job specific conditions require more.
- F. Limit the water side pressure drop on water coils to 15 feet. Limit the air side pressure drop on chilled water coils to 0.90" w.c.
- G. Provide at least 18" of access between coils. Provide an easily operable access panel or door, as shown on drawings.
- H. Provide coil segment casing that meets or exceeds casing performance of the unit.
- I. Provide panels that are easily removable with no special tools.
- J. Locate access doors to provide clearance for pipe insulation, connectors, and accessories. Space shall allow a minimum of 90 degrees of door swing.
- K. Provide coils built in their own full perimeter frame. Tube sheets on each end shall have fully drawn collars to support and protect tubes. Horizontal coil casing and support members shall allow moisture to drain. Casing and support members shall not block finned area.
- L. Individual coils shall be removable from the side of the AHU.
- M. Provide intermediate drain pans on stacked cooling coils (one at every coil break). Intermediate drain pan shall slope in a minimum of two planes toward a single drain connection.
- N. Provide a single intermediate vertical coil support on coils with a finned length greater than 62". Provide two vertical supports on coils with a finned length greater than 100" and three vertical supports on coils with a finned length greater than 141".

- O. Provide a 1/4" FPT plugged vent/drain tap on each connection. Circuiting shall allow draining and venting when installed. Extend vent, drain, and coil connections through AHU casing.
- P. When staggered coil banks are required. Provide a 1/4" FPT plugged vent/drain tap on each connection. Circuiting shall allow draining and venting when installed. Vent, drain, and coil connections shall be supplied within 10" of the header. Extend vent, drain, and coil connections through AHU casing. Insulation of internal chilled water piping shall be insulated by mechanical contractor.
- Q. Insulate gap between coil stub out connection and AHU casing with a spool-shaped sleeve grommet. Adhesive rings applied the casing walls are not acceptable.
- R. Water and glycol coils shall be operable at 250 psig working pressure and up to 300°F. Factory test water and glycol coils with 325 psig compressed air under water.
- S. Direct expansion (DX) coils shall conform to ANSI B9.1 (Safety Code for Mechanical Refrigeration) when operating with a maximum refrigerant pressure of 250 psig. Factory test DX coils with 325 psig compressed air under water. DX coils will be dehydrated and sealed prior to installation.
- T. Provide water, glycol and DX coils with a tube OD of 5/8" and material thickness of 0.025". Mechanically expand tubes to form fin bond and provide burnished, work-hardened interior surface. Turbulators shall not be permitted inside water coils.
- U. Provide water coil headers made of seamless copper or brass tubing. Pipe connections shall be red brass.
- V. Provide coils with die-formed, continuous aluminum fins. Fins shall have fully drawn collars to accurately space fins and protect tubes. Fins shall be 0.008" thick.
- W. Provide coil coatings as scheduled or indicated on drawings.

2.15 DAMPERS

- A. Provide dampers tested in accordance with AMCA 500.
- B. Provide factory-installed dampers, as shown on drawings.
- C. Dampers shall have airfoil blades, extruded vinyl edge seals, and flexible metal compressible jamb seals.
- D. Dampers shall have a maximum leakage rate of 4 CFM/square foot at 1" w.g., and shall comply with ASHRAE 90.1.
- E. Damper blades shall be opposed acting unless otherwise indicated. Parallel blades may be required to promote air mixing.
- F. Damper blades shall be aluminum.

2.16 FILTERS SECTION

- A. Provide filter segments with filters and frames as scheduled. Specify pre-filter racks that provide metal support on the entire perimeter of the pre-filters.
- B. Provide face loading filters for all filter segment(s). Provide an 18" (minimum) access plenum and access door on the drive side through which face loading filters can be easily loaded.
- C. Provide Class 2 or Class 1 filter media per U.L. 900 and as required by local codes.
- D. Filter types, efficiencies, and nominal depths shall be as follows:
 - 1. Rigid filters – 4" mini pleated with efficiencies of 60-65% (MERV 11) for all Pre-filters. 12" rigid, 90-95% (MERV 14) for final filters.
 - a. Provide front loading filter tracks for all filters. Side loading racks are unacceptable.
- E. Provide a flush mounted, factory installed, Magnahelic differential pressure gage on the drive side of unit to measure pressure drop across filters. Manufacturer shall provide fully functional gauges, complete with tubing.

2.17 AIR BLENDERS

- A. Provide static mixing devices by Blender Products, Inc. or approved equal downstream of all outside air sections when the ASHRAE 99.6% winter design dry bulb condition is 38°F or less

to enhance the mixing of outside air with return air to an effectiveness required to eliminate freeze stat trips, minimize sensor, error and enhance outdoor air distribution.

- B. The static mixer shall be capable of a minimum of 70% range mixing effectiveness when mixing 25% outside air with 75% return air at one mixer diameter downstream of mixer.
- C. Multiple mixers may be utilized for OA introduced on top of air handling unit that is full casing width. All side inlet OA arrangements shall utilize single blender or minimum allowable within air handling unit casing and still provide a minimum of 70% range mixing effectiveness.

2.18 AIRFLOW MONITORING STATIONS

- A. All fans shall be provided with factory mounted piezometer rings. Rings shall be factory installed in each fan inlet. The device shall have a measurement accuracy of $\pm 5\%$.
- B. BAS Contractor shall provide a field-installed transducer that sends a CFM-proportional, 4-20 mA or 0-10V signal, as specified in specification section 230913.
- C. Fan array measurement – For arrays having four fans or more, provide FAATS-1000 fan array airflow totalizing system by Paragon Controls or approved equal with one remote transducer per array.

2.19 HUMIDIFIER DISPERSION MANIFOLD

- A. Provide Stainless Steel Short Absorption Manifold designed for atmospheric steam humidifiers or pressurized steam from a boiler, to directly inject the steam into ducted air for humidification.
- B. Provide adequate vertical tube spacing to ensure absorption distance characteristic shall prevent water accumulation on any in-duct surfaces beyond 24 in downstream of the steam dispersion panel.
- C. Steam inlet and condensate return located on the same side and at the bottom of the header to allow single point entry and floor mounting.
- D. Provide headers of 304 stainless steel construction.
- E. Provide vertical, 304 stainless steel distribution tubes to promote condensate evacuation. Horizontal distributor tubes are not accepted.
- F. Stainless steel nozzle inserts shall have metered orifices, sized to provide even distribution of the discharged steam, spaced for optimum steam absorption. Systems without nozzle inserts, or other than stainless steel, are not acceptable.
- G. Provide tube and header insulation constructed from 304 stainless steel shielding for increased energy efficiency and reduced airstream heat gain. Steam header insulation is to minimize heat losses to under 10%. Stainless steel shields to be isolated from distributor using plenum rated synthetic foam strips. Insulation to provide air-gap to minimize conduction and convection, as well provide reflective surface to minimize radiating heat transfer. Un-insulated headers, or simple foam insulation not accepted.

2.20 ULTRAVIOLET LIGHTS

- A. Provide surface decontamination UV fixtures within cooling coil sections for air handlers serving emergency departments, operating rooms, bone marrow areas, PICU, Compounding Pharmacy's and NICUs.
- B. UV system shall be tied to a switch to kill power to the lighting system when the access door is opened. A second manual kill switch shall be provided inside the unit for safety.
- C. UVC products shall be from an ISO 9001 manufacturer or the supplier shall provide proof of 100% inbound and outbound testing of equipment and have at least 10 years' experience as a manufacturer of UVC products for air handling equipment.
- D. Fixtures shall be tested, listed and labeled as UL/C-UL under Category Code ABQK (Accessories, Air Duct Mounted), UL Standards: 153, 1598 & 1995 respectively.
- E. Fixtures shall meet the "UL" drip proof design and each fixture is equipped with an electrical interlock.

- F. Useful lamp life shall be 9000 hours with no more than a 20% output loss at the end of one year of continuous use. They are constructed with UVC proof metal bases and shall not produce ozone.
- G. Each lamp shall contain no more than 8 milligrams of mercury, consistent with current environmental practices, while producing the specified output at 500 fpm in temperatures of 55-135° F.
- H. Lamps and fixtures shall be installed in sufficient quantity and in such a manner so as to provide even distribution of UVC energy on designated surface area (Coil, filter rack, etc.). When installed, the minimum intensity striking any point on a plane representing the surface of the coil or component shall not be less than 50 microwatts per square centimeter. Average radiation shall be 150 microwatts minimum per square centimeter.
- I. The minimal UVC energy striking a surface shall be sufficient to continuously destroy a monolayer of mold and bacteria as typically found in HVAC systems in less than six hours
- J. Lamp fixtures shall be constructed of type 304 stainless steel to preclude corrosion. Support components shall be constructed of type 304 stainless or galvanized cold rolled steel.
- K. Power supply shall be of a high efficiency, high frequency electronic type, matched to the lamp and designed to maximize UVC radiance and reliability. They shall be capable of four wire lamp operation rapid start. They shall be UL Listed and labeled, and comply with FCC 47, Part 18, non-consumer limits requirements. The ballast shall be protected from failure in the event of End of Lamp life lamp failure. The ballast shall be capable of operation indefinitely when powered with no lamp or a failed or broken lamp. Track mounted fixture ballasts shall have 120VAC or 240 VAC input. Strut mounted ballasts shall have universal input (100VAC to 277VAC). Track mounted fixtures shall be capable of producing the output as specified under Irradiation and Intensity at no more than 13Watts of power consumption for each square foot of treated, cross sectional plane.
- L. Ballast system shall not proprietary to the manufacturer of the UV bulb.
- M. Provide and install a UV radiometer for monitoring bulb intensity near center of coil - tie to BAS. Set BAS to alarm operator when bulb intensity drops below manufacturer-recommended threshold.
- N. Original purchase of equipment has to include service contract to replace bulbs once per year for five years after startup. Contract must include materials and labor to install new and dispose of old bulbs.

2.21 APPURTENANCES

- A. For motors 7.5HP and larger in the stacked position, provide internal structural I-Beam motor removal rail with structural frame to distribute motor weight to unit base. Rail shall be perpendicular to centerline of access door for ease of removal.
- B. Provide rain hoods on outdoor unit air intakes, as shown on drawings. Provide moisture screens on outdoor air inlet rain hoods.
- C. Provide steel base rails suitable for rigging and lifting, as shown on product drawings.
- D. Provide safety grates over bottom openings, as shown on drawings.
- E. Safety grates shall be capable of supporting a 300 lb. center load.
- F. Provide lifting lugs where required.

2.22 FINISHES

- A. Manufacturer shall clean the exterior surfaces of units prior to finishing, painting, or shipment.
- B. Unpainted air-handling units constructed of galvanized steel shall pass the ASTM B-117 test for 220-hour salt spray solution (5%) without any sign of red rust. (confirm)
- C. Manufacturer shall paint outdoor units prior to shipment. Manufacturer shall paint indoor units, as scheduled or shown on drawings.
 - 1. Manufacturer shall apply a primer prior to painting units.
 - 2. Manufacturer shall apply a finish coat of acrylic polyurethane paint.

3. Finished unit shall exceed 500-hour salt spray solution (5%) test without any sign of red rust when tested in accordance with ASTM B-117.

2.23 TESTS AND INSPECTIONS

- A. Manufacturer shall dynamically balance fan/motor/base assembly.
 1. Balance constant volume fan assemblies at design RPM.
 2. Balance variable volume fan assemblies from 10% to 100% of design RPM.
 3. Take filter-in measurements in the horizontal and vertical axes on the drive and opposite-drive sides of fan shafts.
 4. Constant speed fan vibration limits: filter-in measurements shall not exceed 4 mils.
 5. Variable speed fan vibration limits: filter-in measurements shall not exceed 7 mils.
- B. Manufacturer shall hi-pot test wiring intended to carry voltages greater than 30VAC.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which air handling units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION, GENERAL

- A. Install equipment per industry standards, applicable codes, and manufacturer's instructions.
- B. Do not use AHUs for temporary heating, cooling or ventilation prior to complete inspection and startup performed per this specification.
- C. Install rooftop AHUs on a roof curbs, as shown on drawings. To reduce the potential for noise complaints, retain the maximum amount of roof mass under the unit and locate rooftop units over non-sound sensitive area. Where possible, cut openings in roof for duct and pipe penetrations – do not open roof to entire area under curb. Provide sound plenums within building to reduce sound transmission. Sound plenum construction shall be thoroughly detailed.
- D. Install all AHUs on elevated slabs not over a mechanical room on floating floor arrangement per HCA standard detail.
- E. Install AHUs with manufacturer's recommended clearances for access, coil pull, and fan removal.
- F. Install AHU plumb and level. Connect piping and ductwork according to manufacturer's instructions.
- G. Install seismic restraints and anchors per applicable local building codes. Refer to specification Section 230548 (15240 / 15070) for product and installation requirements.
- H. Install pipe chases per manufacturer's instructions.
- I. Insulate plumbing associated with drain pan drains and connections. Run condensate to nearest floor drain or roof drain.
- J. Install insulation on all staggered coil piping connections, both internal and external to the unit.
- K. If access to the interior of the air handler for maintenance and repair cannot be gained without a ladder, a permanent access ladder must be provided. Install platforms and access ladders to permit full maintenance of the upper level of stacked air handlers. Platform and support structure shall not obstruct door swing, coil pull, and other reasonable maintenance access to the lower level.
- L. Store per AHU manufacturer's written recommendations. Store AHUs indoors in a warm, clean, dry place where units will be protected from weather, construction traffic, dirt, dust, water and moisture. If units will be stored for more than 6 months, follow manufacturer's instruction for long-term storage.
- M. Rig and lift units according manufacturer's instructions.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:
1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.
 2. Connection piping to air-handling units with flexible connectors.
 3. Connect water supply piping to the air leaving side of water coils.
 4. Route unit condensate drain piping to location shown on the plan or, if not shown, to the nearest equipment or floor drain. Construct deep trap, minimum of 1" deeper than fan pressure in inches of water, at connection to drain pan and install cleanouts at changes in direction. Size condensate drain piping in accordance with local code and the following:
- | <u>Piping Length</u> | <u>Size</u> |
|----------------------|---|
| Less than 10 feet | Same size as unit connection |
| More than 10 feet | One pipe size larger than unit connection |
- B. Duct installations and connections are specified in other Division 23 sections. Make final duct connections with flexible connections.
- C. Electrical Connections: The following requirements apply:
1. Electrical power wiring is specified in Division 26.
 2. Temperature control wiring and interlock wiring is specified in Division 23 section "Direct-Digital Control for HVAC."
- D. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.04 ADJUSTING, CLEANING, AND PROTECTING

- A. Adjust water coil flow, with control valves to full coil flow, to indicated gpm.
- B. Adjust damper linkages for proper damper operation.
- C. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, intake plenum cabinet, heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.

3.05 STARTUP

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.
- B. Comply with manufacturer's start-up requirements to ensure safe and correct operation and integrity of warranty.
- C. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
1. Remove shipping, blocking, and bracing.
 2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
 3. Perform cleaning and adjusting specified in this Section.
 4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 6. Set zone dampers to full open for each zone.
 7. Set face-and-bypass dampers to full face flow.
 8. Set outside-air and return-air mixing dampers to minimum outside-air setting.

9. Comb coil fins for parallel orientation.
10. Install clean filters. Do not operate air handling unit without pre-filters installed.
11. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
12. Disable automatic temperature control operators.
- D. Start-Up Procedures: Start-up air-handling units in accordance with manufacturer's written start-up instructions and as specified herein. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
 1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
 - a. Replace fan and motor pulleys as required to achieve design conditions.
 - b. Measure and record motor electrical values for voltage and amperage.
 - c. Shut unit down and reconnect automatic temperature control operators.
 - d. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for air-handling-system testing, adjusting, and balancing.

3.06 AHU INSPECTION

- A. Installing Contractor to perform an inspection of unit and installation prior to startup. Start-up report submitted to general contractor shall verify the following as a minimum:
 1. Damage of any kind
 2. Level installation of unit
 3. Proper reassembly and sealing of unit segments at shipping splits.
 4. Tight seal around perimeter of unit at the roof curb
 5. Installation of shipped-loose parts, including filters, air hoods, bird screens and mist eliminators.
 6. Completion and tightness of electrical, ductwork and piping
 7. Tight seals around wiring, conduit and piping penetrations through AHU casing.
 8. Supply of electricity from the building's permanent source
 9. Integrity of condensate trap for positive or negative pressure operation
 10. Condensate traps charged with water
 11. Removal of shipping bolts and shipping restraints
 12. Sealing of pipe chase floor(s) at penetration locations.
 13. Tightness and full motion range of damper linkages (operate manually)
 14. Complete installation of control system including end devices and wiring
 15. Cleanliness of AHU interior and connecting ductwork
 16. Proper service and access clearances
 17. Proper installation of filters
 18. Filter gauge set to zero
- B. Resolve any non-compliant items prior to unit start-up.

3.07 INSPECTION AND ADJUSTMENT: AHU FAN ASSEMBLY

- A. Hire the manufacturer's factory-trained and factory-employed service technician perform an inspection of the AHU fan assembly subsequent to general AHU inspection and prior to startup. Technician shall inspect and verify the following as a minimum:
 1. Fan isolation base and thrust restraint alignment
 2. Tight set screws on pulleys, bearings and fan
 3. Tight fan bearing bolts
 4. Tight fan and motor sheaves

5. Tight motor base and mounting bolts
6. Blower wheel tight and aligned to fan shaft
7. Sheave alignment and belt tension
8. Fan discharge alignment with discharge opening
9. Fan bearing lubrication
10. Free rotation of moving components (rotate manually)

3.08 TRAINING

- A. Manufacturer's factory-trained and factory-employed service technician shall startup AHUs. Technician shall perform the following steps as a minimum:
 1. Energize the unit disconnect switch
 2. Verify correct voltage, phases and cycles
 3. Energize fan motor briefly ("bump") and verify correct direction of rotation.
 4. Re-check damper operation; verify that unit cannot and will not operate with all dampers in the closed position.
 5. Energize fan motors and verify that motor FLA is within manufacturer's tolerance of nameplate FLA for each phase.
- B. Provide a minimum of 4 hours of training for owner's personnel by manufacturer's factory-trained and factory-employed service technician. Training shall include AHU controls, motor starter, VFD, and AHU.
- C. Training shall include startup and shutdown procedures as well as regular operation and maintenance requirements.
- D. If AHU is provided with a factory-mounted variable frequency drive (VFD), hire the VFD manufacturer's factory-trained and factory-authorized service technician to inspect, test, adjust, program and start the VFD. Ensure that critical resonant frequencies are programmed as 'skip frequencies' in the VFD controller.
- E. If AHU is provided with a factory-mounted humidifier, hire the humidifier manufacturer's factory-trained and factory-authorized service technician to inspect, test, adjust and verify proper operation in conjunction with BAS contractor.
- F. Submit a startup report summarizing any problems found and remedies performed.
- G. Permanent air handling equipment shall not be started under any circumstances until dust-generating construction activities such as drywall sanding and floor grinding are complete and the space is entirely cleaned. Until that time, the air handler shall be properly sealed to eliminate dust collecting inside the unit.

3.09 CLEANING

- A. Clean unit interior prior to operating. Remove tools, debris, dust and dirt.
- B. Clean exterior prior to transfer to owner.

3.10 DOCUMENTATION

- A. Provide Installation Instruction Manual, & Startup checklist in the supply fan section of each unit.
- B. Provide six copies of Spare Parts Manual for owner's project system manual.

END OF SECTION 23 73 13

SECTION 23 84 13 HUMIDIFIERS (DISPERSION TYPE)

PART 1 - GENERAL

1.01 SUMMARY

- A. Scope: Extent of humidifier work required by this Section is indicated on the drawings and schedules, and by requirements of this Section, and Division 23 Section "General Mechanical Requirements."
- B. Types: Types of humidifiers specified in this Section include:
 - 1. Steam Jacket Dispersion Tube Humidifiers.
 - 2. Steam Injection Humidifier with Dispersion Tube Panel.
 - 3. Packaged Vertical Dispersion Tube.
- C. Packaged Systems: Humidifiers furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division 23 Sections.
- D. Refer to other Division 23 Sections for:
 - 1. Metal Ducts
 - 2. Direct-Digital Control for HVAC
 - 3. HVAC Insulation
 - 4. Testing, Adjusting and Balancing for HVAC
- E. Refer to Division 26 Sections for power wiring and disconnects.

1.02 QUALITY ASSURANCE

- A. Codes and Standards: Provide humidifiers conforming to the following standards:
 - 1. Underwriters Laboratories, Inc. (UL) or Electrical Testing Laboratories (ETL): Provide electric humidifiers with UL or ETL label and listing.
- B. Certification: Provide humidifiers whose performances, under specified operating conditions, are certified by the manufacturer.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of the Contract and Division 1 Specification Sections.
 - 1. Product Data: Submit manufacturer's humidifier specifications, installation and start-up instructions, and current humidifier performance information with selection points clearly indicated.

2. Shop Drawings: Submit manufacturer's shop drawings indicating dimensions, required clearances and methods of assembly of components.
3. Wiring diagrams detailing wiring for power and controls and differentiating between manufacturer-installed wiring and field-installed wiring.
4. Maintenance data for humidifiers, for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 23 Section "General Mechanical Requirements."

1.04 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Handle humidifiers carefully to prevent damage, denting and scoring. Do not install damaged humidifiers or components; replace with new.
- B. Storage: Store humidifiers and components in a clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Steam Jacket Dispersion Tube Humidifiers

1. Armstrong Intl., Inc.
2. Dri-Steem Humidifier
3. Neptronic
4. Nortec Industries

B. Steam Injection Humidifier with Dispersion Tube Panel

1. Armstrong Intl., Inc.
2. Dri-Steem Humidifier
3. Hygromatik, Div. Of Spirax Sarco
4. Neptronic
5. Nortec Industries
6. Pure Humidifier Co.

C. Packaged Vertical Dispersion Tube Pane

1. Armstrong Intl., Inc.
2. Dri-Steem Humidifier
3. Neptronic
4. Nortec Industries

2.02 GENERAL

- A. Humidifiers: Provide factory fabricated humidifiers of arrangements and capacities indicated. Water atomizing humidifiers shall not be used.

2.03 STEAM JACKETED DISPERSION TUBE HUMIDIFIERS

- A. Type: Provide duct or air handling unit mounted humidifiers with steam jacketed dispersion tubes, condensate separators and automatic control valves.

- B. Dispersion Tubes: Provide dispersion tubes as follows:

1. Provide dispersion tubes designed to evenly distribute the specified quantity of steam uniformly over the entire cross section of the air stream.
2. Provide single or multiple dispersion tube manifolds as required to achieve total steam absorption in a steam travel distance or 3 feet or less.
3. Provide dispersion tubes designed so that steam passes in the jacket around the dispersion tube to superheat the steam in the dispersion tube and re-evaporate any moisture present to ensure dry steam is discharged into the air stream.
4. Construct dispersion tubes and steam jackets of 304 stainless steel.
5. Provide sound absorbing material to muffle steam noise. Sound absorbing material in contact with steam or condensate shall be stainless steel.
6. Provide insulated dispersion tubes and manifolds for all humidifiers installed in dual duct and multizone systems. Insulate the tubes with 1/2-inch fiberglass. Provide type 304 stainless steel, 22 gauge jacket over insulation.

- C. Condensate Separator: Provide condensate separator as follows:

1. Provide cast iron or 304 stainless steel condensate separators to remove moisture from steam prior to entering dispersion tube.
2. Provide a float and thermostatic or inverted bucket trap to drain condensate from separator.

- D. Automatic Control Valve: Provide automatic control valve as follows:

1. Provide a modulating automatic control valve with modified linear control characteristics, selected by the manufacturer of the humidifier to match the capacity of the humidifier.

2. Provide automatic control valves with bronze or cast iron bodies and bronze or stainless steel trim.
3. Provide modulating electric or pneumatic valve actuators compatible with other control system components specified under Division 23.

2.04 STEAM INJECTION HUMIDIFIER WITH DISPERSION TUBE PANEL

A. Type: Provide duct or air handling unit mounted humidifiers with dispersion tube panel, condensate separators and automatic control valves.

B. Condensate Separator: Provide condensate separator as follows:

1. Provide cast iron or 304 stainless steel, centrifugal type condensate separators to remove moisture from steam prior to entering dispersion tube panel.
2. Provide a float and thermostatic or inverted bucket trap to drain condensate from separator.

C. Automatic Control Valve: Provide automatic control valve as follows:

1. Provide a normally closed, modulating automatic control valve with modified linear control characteristics, selected by the manufacturer of the humidifier to match the capacity of the humidifier.
2. Provide automatic control valves with bronze or cast iron bodies and stainless steel parabolic type plug and stainless steel trim.
3. Provide electronic valve actuators compatible with other control system components specified under Division 23 Section "Instrumentation and Control Devices for HVAC."

D. Dispersion Tube Panel: Provide dispersion tube panel as follows:

1. Provide horizontal header and vertical dispersion tube panel designed to evenly distribute the specified quantity of steam uniformly over the entire cross section of the air stream. Vertical headers are not allowed.
2. Provide multiple dispersion tubes as required to achieve total steam absorption in the steam travel distance as scheduled on the drawings.
3. Construct headers and dispersion tubes and steam jackets of 304 stainless steel. Provide stainless steel casing for duct-mounted humidifiers.

4. Stainless steel nozzle inserts shall have metered orifices, sized to provide even distribution of the discharged steam, spaced for optimum steam absorption. Systems without nozzle inserts are not allowed.
5. Provide tube and header insulation constructed from 304 stainless steel shielding. Steam header insulation shall be as required to minimize heat losses to under 10%. Stainless steel shields to be isolated from distributor using plenum rated synthetic foam strips. Insulation to provide air-gap to minimize conduction and convection, as well provide reflective surface to minimize radiating heat transfer. Un-insulated headers, or simple foam insulation not accepted. Provide sound absorbing material to muffle steam noise. Sound absorbing material in contact with steam or condensate shall be stainless steel.
6. Steam and condensate pipe connections shall be on the same side of the unit.

2.05 PACKAGED VERTICAL DISPERSION TUBE PANEL

- A. Humidifier shall consist of an air handling unit mounted or duct mounted, packaged vertical dispersion panel, pressurized steam supply, sloped condensate collection header, automatic control valve, and vertical steam dispersion tubes.
- B. Steam dispersion vertical tubes and horizontal headers shall be Type 304 stainless steel. Vertical headers are not allowed. Tubes shall be insulated with a closed-cell insulation. The steam header shall be insulated with 1/2" rigid acrylic polymer coated fiberglass. Insulation shall meet NFPA requirements. Provide welded joints and gaskets for the tubes. Dispersion tubes shall be designed so that steam passes in the jacket around the dispersion tube to superheat the steam in the dispersion tube and re-evaporate any moisture present to ensure dry steam is discharged into the airstream.
- C. Provide sound absorbing material to muffle steam noise. Sound absorbing material in contact with steam or condensate shall be stainless steel.
- D. The panel casing shall be contained within a galvanized steel casing to allow for installation inside of the AHU.
- E. Distribution manifold shall distribute steam over the entire cross-section of the AHU. Provide all manifold supports for a complete installation. The bottom of the manifold shall be installed a minimum 1'-0" off the AHU floor. The maximum vapor trail shall be limited to 1'-6".
- F. Provide with an electric operated steam control valve with spring return for normally closed operation and solenoid valve. Valve shall include stainless steel trim and electric actuator. Coordinate voltage with the controls contractor.
- G. Provide electric temperature switch to prevent humidifier operation until the start-up condensate is drained and the humidifier is at temperature.
- H. Humidifier shall include float and thermostatic trap and inverted bucket trap to allow for condensate lift. Coordinate capacities and pressures with the scheduled information in the specifications.

- I. High humidity limit switch, manual reset, adjustable set-point, and NEMA 1 enclosure, shall be provided by the Controls Contractor and shall be wired to defeat the humidifier.
- J. Humidifier manifold shall be installed by the AHU manufacturer at the factory. Provide all supports where required by the humidifier manufacturer.
- K. Steam and condensate connections shall be on same side of unit.
- L. Steam and Condensate piping shall be routed through the piping vestibule roof curb area and into the humidifier section of AHU casing for connection in field by others. All steam and condensate piping necessary to connect multiple distribution manifolds within the unit shall be provided by unit manufacturer. Refer to AHU layout for the piping locations.
- M. Provide an electric operated solenoid valve, two-position, normally closed, solenoid operated and on-off steam valve.
- N. Provide a modulating automatic control valve with modified linear control characteristics, selected by the manufacturer of the humidifier to match the capacity as scheduled. Valve shall be bronze or cast-iron body, bronze or stainless steel trim and include end switch. Coordinate electric valve actuator with the facility DDC contractor.
- O. Provide in-line Y-pattern strainer for installation at the inlet to the electric steam control valves.

2.06 ACCESSORIES:

- A. General: Provide accessories with humidifiers as follows:
 - 1. Provide high limit duct humidistat to shut down humidifier on sensing of high humidity level to protect against saturation of duct airstream.
 - 2. Provide electric type airflow proving switch to lock out humidifier when no airflow is sensed.
 - 3. Provide temperature switch to prevent cold startup of humidifier.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General: Install humidifiers in accordance with the manufacturer's instructions and in an arrangement that will permit access and ease of maintenance.
- B. Steam and condensate piping: Provide piping as indicated including unions, strainers, steam traps, dirt legs and shutoff valves.

C. Water piping: Provide piping as indicated including unions, shutoff valves, strainers and pressure regulating valves.

D. Drain Piping: Provide drain piping as indicated including unions and traps and run to nearest floor drain.

3.02 FIELD QUALITY CONTROL

A. Provide the services, to include a written report, of a factory authorized service representative to supervise the field assembly of the components, installation, and piping and electrical connections.

3.03 DEMONSTRATION

A. Provide the services of a factory authorized service representative to provide start-up service and to demonstrate proper operation of equipment, accessories and controls.

3.04 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.
2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
4. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

C. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 238413

SECTION 26 00 10 GENERAL ELECTRICAL REQUIREMENTS

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 and to all following sections within Division 26.

1.02 SECTION INCLUDES

- A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.
- B. Division 26 of these Specifications, and Drawings numbered with prefixes E, generally describe these systems, but the scope of the electrical Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.
- C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of Work, indicating the intended general arrangement of the equipment, fixtures, outlets and circuits without showing all of the exact details as to elevations, offsets, control lines, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.03 DEFINITIONS

- A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:
 - 1. Furnish: "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."
 - 2. Install: "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."
 - 3. Provide: "To furnish and install complete, and ready for the intended use."
 - 4. Furnished by Owner (or Owner-Furnished) or Furnished by Others: "An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division."
 - 5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division.
 - 6. Contract Administrator: The primary liaison between the Owner and the Contractor. When used in this Division it means "the Architect".

7. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
 8. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTLs that are acceptable to the AHJ, and standards that meet the specified criteria.
 9. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
 - a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
 10. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
- C. Manufacturers: The listing of specific manufacturers does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety.

1.04 REFERENCE STANDARDS

- A. Execute all Work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of Work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator's and Engineer's attention in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.
- B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Engineer, without additional compensation. Contractor will be held responsible for any violation of the law.
- C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.

- D. All material, manufacturing methods, handling, dimensions, methods of installation, and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them:

IBC	International Building Code
ADA	Americans with Disabilities Act
AIA	Guidelines for Design and Construction of Hospital and Healthcare Facilities
AEIC	Association of Edison Illuminating Companies
ANSI	American National Standards Institute
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
ICEA	Insulated Conductors Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code, NFPA 70
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers' Association
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Act
UL	Underwriter's Laboratories

- E. Comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. Perform all electrical work in compliance with applicable safety regulations, including OSHA regulations. All safety lights, guards, and warning signs required for the performance of the electrical work shall be provided by the Contractor.
- G. Obtain and pay for all permits, licenses and fees that are required by the governing authorities for the performance of the electrical work.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with other Divisions for electrical work included in them but not listed in Division 26 or indicated on electrical Drawings.
- B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any Work covered by this Division.
- C. Refer to Drawings and Divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Make all offsets required to clear equipment, beams and other structural members, and to facilitate concealing conduit in the manner anticipated in the design.
- D. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes actually installed.
- E. Maintain an electrical foreman on the jobsite at all times to coordinate this Work with other trades so that various components of the electrical systems is installed at the proper time, fits the available space, and allows proper service access to all equipment. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.
- F. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Contract Administrator. Cooperate in establishing these

schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.

1.06 MEASUREMENTS AND LAYOUTS

- A. The Drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

1.07 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements, in addition to requirements specified herein.
- B. Submittals and shop drawings shall not contain HEI's firm name or logo, nor shall they contain the HEI engineer's seal and signature. They shall not be copies of HEI's work product. If the Contractor desires to use elements of such product, the license agreement for transfer of information at the end of this Section must be used.
- C. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division. Provide the number of submittals required by Division 1; if hard-copy sets are provided, submit a minimum of seven (7) sets. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- D. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- E. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- F. Refer to individual Sections for additional submittal requirements.
- G. Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time, plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittals, if required. Transmit submittals as soon as possible after Notice to Proceed and before Electrical construction starts.
- H. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- I. Submittals shall contain the following information:
 - 1. The project name.
 - 2. The applicable specification section and paragraph.
 - 3. Equipment identification acronym as used on the drawings.
 - 4. The submittal date.
 - 5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
 - 6. Submittals not so identified will be returned to the Contractor without action.
- J. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Contract Administrator and

Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contractor Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

- K. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from the Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.

1.08 SUBSTITUTIONS

- A. Refer to Division 1 and General Conditions for substitutions in addition to requirements specified herein.
- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:
1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
 - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
 - c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
 - d. Same warranty will be furnished for proposed substitution as for specified Work.
 - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
 - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.
- E. Substitution Consideration:
1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
 2. No substitutions will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.
 3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
 4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.09 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet.
- B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.
- C. Contact the Architect for Architect's written authorization.
- D. The following must be received before electronic drawing files will be sent:
 - 1. Architect's written authorization
 - 2. Engineer's release agreement form
 - 3. Payment

1.10 QUALITY ASSURANCE

- A. Execute all Work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the Work specified.
- B. Install all Work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.
- C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

1.11 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish to the Contract Administrator, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees.
- F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access

the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives.

1.12 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections of this Division

1.13 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.
- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

1.14 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.
- D. Be responsible for the safe storage of tools, material and equipment.

1.15 WARRANTIES

- A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in these Construction Documents or manufacturer's standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.
- D. Also warrant the following additional items:
 - 1. All raceways are free from obstructions, holes, crushing, or breaks of any nature.
 - 2. All raceway seals are effective.
 - 3. The entire electrical system is free from all short circuits and unwanted open circuits and grounds.

- E. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.
- F. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.
- G. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.16 TEMPORARY FACILITIES

- A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.
- B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.
- C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.
 - 1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.
 - 2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees F. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Vent fuel-burning heaters, and equip units with individual-space thermostatic controls. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

1.17 FIELD CONDITIONS

- A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:
 - 1. The Drawings describe the general nature of remodeling to the existing building; however, visit the Site prior to submitting bid to determine the nature and extent of work involved.
 - 2. Schedule Work in the existing building with the Owner.
 - 3. Perform certain demolition work prior to the remodeling. Perform the demolition that involves electrical systems, Light fixtures, equipment, raceways, equipment supports or foundations and materials.
 - 4. Remove articles that are not required for the new Work. Unless otherwise indicated, remove each item removed during this demolition from the premises and dispose in accordance with applicable federal, state and local regulations.
 - 5. Relocate and reconnect electrical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where electrical equipment or materials are removed, cap unused raceways below the floor line or behind the wall line to facilitate restoration of finish.
 - 6. Finish material will be installed under other Divisions.
 - 7. Obtain permission from the Contract Administrator for channeling of floors or walls not specifically noted on the Drawings.

8. Protect adjacent materials indicated to remain. For Work specific to this Division, install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 9. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, provide temporary services for affected areas.
- B. Use of explosives is not permitted.
- C. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

(Not Used)

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install all products and materials in accordance with manufacturer's instructions.

3.02 EXISTING CONDITIONS

- A. Existing conditions indicated on the Drawings are taken from the best information available from the Owner, existing record drawings, and from limited, in-situ, visual site observations; and, they are not to be construed as "AS BUILT" conditions. The information is shown to help establish the extent of the new Work.
- B. Verify all actual existing conditions at the project site and perform the Work as required to meet the existing conditions and the intent of the Work indicated.

3.03 WORK IN EXISTING FACILITIES

- A. The Drawings describe the general nature of remodeling to the existing facilities; however, visit the Site prior to submitting a Bid, to determine the nature and extent of Work involved.
- B. Schedule Work in the existing facility with the Owner.
- C. Certain demolition work shall be performed prior to the remodeling. Perform the demolition that involves electrical systems, fixtures, conduit, wiring, equipment, equipment supports or foundations and materials.
- D. Remove all of these articles that are not required for the new Work. Unless otherwise indicated, each item removed during this demolition shall be removed from the premises and disposed of in accordance with all state and local regulations.
- E. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Contract Administrator and the Owner's written permission.
 3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.
 4. Contractor shall maintain contingency work plans should Owner be required to alter allowable working hours on short notice or require Contractor to cease work as previously

described. Contractor contingency plan shall allow efficient use of their personnel in other areas or perform other portions of the Work when Owner exercises the right to deny Contractor access to specific areas. Additional payment to the Contractor will not be allowed as a result of Owner's denial of access to areas within the Facility.

- F. Relocate and reconnect all electrical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where electrical fixtures or equipment are removed, cap all unused raceways behind the floor line or wall line to facilitate restoration of finish, and, remove all existing wiring from abandoned raceways.
- G. Finish materials are specified in other Divisions.
- H. Where removal of existing wiring interrupts electrical continuity of circuits that are to remain in use, provide necessary wiring, raceways, junction boxes, etc., to ensure continued electrical continuity.
- I. Channel walls and floors as required to produce the desired result; however, obtain permission from the Contract Administrator for all channeling not specifically noted on the Drawings.
- J. Provide new, typewritten card directory for distribution equipment (including but not limited to load centers, panelboards, switchboards and switchgear) where changes occur under this scope of work. Indicate exact loads served by each existing circuit breaker or switch.

3.04 PERMITS

- A. Secure and pay for all permits required in connection with the installation of the Electrical Work. Arrange with the various utility companies for the installation and connection of all required utilities for this facility and pay all charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.05 TEMPORARY ELECTRICAL SERVICE AND WIRING

- A. Provide 208Y/120 volt, three-phase, four-wire, temporary electrical service and temporary lighting system to facilitate construction.
- B. In existing facilities, with Owner's approval, Contractor may utilize the existing electrical system as the source of temporary power. Coordinate the point of connection and method of connection to the existing system with the Owner's Representative.
- C. The Owner will pay all charges made by the Electrical Utility, with respect to installation and energy charges for temporary services.]
- D. Work for the temporary power shall consist of all labor and materials, including, but not limited to conduit, wiring, panelboards, fuse blocks, fused disconnecting switches, fuses, pigtails, receptacles, wood panel switch supports, and other miscellaneous materials required to complete the power system.
- E. Install all temporary wiring in accordance with applicable codes, and maintain in an OSHA-approved manner.
- F. Provide an adequate number of GFCI type power distribution centers, rated 208Y/120V, four-wire, and not less than 60A, with sufficient fuse blocks or breakers for lighting and hand tool circuits, 60A four-wire feeders, all mounted within pre-fabricated enclosures UL listed for this application or on suitable wood panels bolted to columns or upright wood supports as required.
- G. Install circuits to points on each level of each building so that service outlets can be reached by a 50-foot extension cord for 120V power and a 100-foot extension cord for 208V power (or as required by OSHA or local authorities).
- H. Provide one lighting outlet per 30 linear feet of corridor and at least one light in each room and for every 800 square feet of floor area. Temporary lighting shall comply with OSHA requirements.
- I. If additional service is required for cranes, electrical welders or for electric motors over 1/2 HP per unit, such additional service shall become the responsibility of the trade involved.

- J. When the permanent wiring for lighting and power is installed, with approval of the Contract Administrator and Owner, the permanent system may be used, provided the Contractor assumes full responsibility for all electrical material, equipment, and devices contained in the systems and provided that roof drainage system and roofing are complete.
- K. When directed by the Contract Administrator, remove all temporary services, lighting, wiring and devices from the property.

3.06 SELECTIVE DEMOLITION

- A. Refer to Division 01, Division 02, and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.
- B. General: Demolish, remove, demount, and disconnect abandoned electrical materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- C. Materials and Equipment To Be Salvaged: remove, demount, disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- E. Electrical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete raceways, fittings, supports and specialties, equipment, wiring, controls, fixtures, and insulation:
 - a. Raceways and outlets embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Cut embedded raceways to below finished surfaces, seal, and refinish surfaces as specified or as indicated on the Architectural finish Drawings. Remove materials above accessible ceilings. Cap raceways allowed to remain.
 - b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 26.

3.07 ACCESS TO EQUIPMENT

- A. Locate all pull boxes, junction boxes and controls so as to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section "Common Work Results for Electrical".
- B. Maintain all code required clearances and clearances required by manufacturers.

3.08 PENETRATIONS

- A. Unless otherwise noted as being provided under other Divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 26 Section "Common Work Results for Electrical".
- B. Provide sleeves, box frames, or both, for all conduit, cable, and busways that pass through masonry, concrete or block walls.
- C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.

3.09 CUTTING AND PATCHING

- A. Provide all necessary cutting of walls, floors, ceilings and roofs for work under this Division.
- B. Cut no structural member without permission from Contract Administrator.
- C. Patch around all openings to match adjacent construction.
- D. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Contract Administrator.

3.10 PAINTING

- A. Refer to Division 09 Section "Painting" for painting requirements.

- B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual Sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.
- C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
- D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
- E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

3.11 CLEANING

- A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from Work and assist in making the premises broom clean. Clean all material and equipment installed under this Division.
- C. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.
- D. Touch up and restore damaged finishes to their original condition.

3.12 ADJUSTING, ALIGNING AND TESTING

- A. Adjust, align and test all electrical equipment furnished and/or installed under this Division.
- B. Check motors for alignment with drive and proper rotation, and adjust as required.
- C. Check and test protective devices for specified and required application, and adjust as required.
- D. Check, test and adjust adjustable parts of all light fixtures and electrical equipment as required to produce the intended performance.
- E. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.
- F. After completion, perform tests for continuity, unwanted grounds, and insulation resistance in accordance with the requirements of NFPA 70 and NETA.
- G. Be responsible for the operation, service and maintenance of all new electrical equipment during construction and prior to acceptance by the Owner of the complete project under this Contract. Maintain all electrical equipment in the best operating condition including proper lubrication.
- H. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.
- I. Maintain service and equipment for all testing of electrical equipment and systems until all Work is approved and accepted by the Owner.
- J. Keep a calibrated voltmeter and ammeter (true RMS type) available at all times. Provide service for test readings when and as required.
- K. Refer to individual Sections for additional and specific requirements.

3.13 START-UP OF SYSTEMS

- A. Prior to start-up of electrical systems, check all components and devices, lubricate items appropriately, and tighten all screwed and bolted connections to manufacturers' recommended torque values using appropriate torque tools.
- B. Each power, lighting and control circuit shall be energized, tested and proved free of breaks, short-circuits and unwanted grounds.
- C. Adjust taps on each transformer for rated secondary voltages.

- D. Balance all single phase loads at each panelboard, redistributing branch circuit connections until balance is achieved to plus or minus 10 percent.
- E. After all systems have been inspected and adjusted, confirm all operating features required by the Drawings and Specifications and make final adjustments as necessary.
- F. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.
- G. At the time of final review and tests of the power and lighting systems, all equipment and system components shall be in place and all connections at panelboards, switches, circuit breakers, and the like, shall be complete. All fuses shall be in place, and all circuits shall be continuous from point of service connections to all switches, receptacles, outlets, and the like.

3.14 TEST REPORTS

- A. Perform tests as required by these Specifications and submit the results in the operations and maintenance manuals. The tests shall establish the adequacy, quality, safety, and reliability for each electrical system installed. Notify the Contract Administrator and Engineer two working days prior to each test.
- B. For specific testing requirements of special systems, refer to the Specification section that describes that system.
- C. Upon completing each test, record the results, date and time of each test and the conditions under which the test was conducted. Submit to the Contract Administrator, for Engineer's review, in duplicate, the test results for the following electrical items:
 - 1. Voltages (phase-to-phase and phase-to-neutral) and amperes at each phase for each panelboard, switchboard, and the like.
 - 2. Phase voltages and amperes at each three-phase motor.
 - 3. Test all wiring devices for electrical continuity and proper polarity of connections.
- D. Promptly correct all failures or deficiencies revealed by these tests as determined by the Engineer.

3.15 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
 - 1. Submit complete Operation and Maintenance Data.
 - 2. Submit complete Record Drawings.
 - 3. Perform all required training of Owner's personnel.
 - 4. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
 - 5. Perform start-up tests of all systems.
 - 6. Remove all temporary facilities from the site.
 - 7. Comply with all requirements for Substantial Completion in the Division 01 and General Conditions.
- B. Request in writing a review for Substantial Completion. Give the Contract Administrator at least seven (7) days notice prior to the review.
- C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, he shall reimburse the Contract Administrator and Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Contract Administrator will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 26 00 10

SECTION 26 00 15 ELECTRICAL MATERIALS PURCHASING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section falls under the guidelines established in HCA Innovation Memo #16 – Electrical Materials. If conflicts exist between the information here included and the guidelines established by the Innovation Memo, the Innovation Memo is to take precedent.
 - B. Existing manufactured gear does not preclude the partnering vendors listed above from providing an “as equal” solution for consideration and evaluation. Partner manufacturers for power switchgear/power are Eaton and Schneider.
 - C. If products needed or required are not available under the agreement they will be identified by the engineer of record and may be procured through traditional channels. Contact engineer of record and/or HCA engineering for questions and clarifications.
- 1. Pricing and Purchasing of materials described under the following specification sections is to be through either or both of CED-Nashville and Graybar-Nashville.
 - a. CED-Nashville; 330 19th Ave. North – Nashville, TN – 37203; Attn: Lance Smith; HCA@ced-nashville.com; (615) 329-2601 or (615) 207-7223
 - b. Graybar-Nashville; 825 8th Ave. South – Nashville, TN – 37217; Attn: Jess Hoover; HCA@graybar.com; (615) 743-3232 or (239) 494-2088

260500 COMMON WORK RESULTS FOR ELECTRICAL
260502 EQUIPMENT WIRING SYSTEMS
260510 COMMON WORK FOR COMMUNICATIONS (NON-COLLECTIVE TECH)
260519 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
260526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
260529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
260533 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS
260553 IDENTIFICATION FOR ELECTRICAL SYSTEMS
260573 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY
260923 LIGHTING CONTROL DEVICES
262200 LOW-VOLTAGE TRANSFORMERS
262416 PANELBOARDS
260543 UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS
262726 WIRING DEVICES
262813 FUSES
264313 SURGE PROTECTIVE DEVICES
265100 INTERIOR LIGHTING
265600 EXTERIOR LIGHTING

END OF SECTION 26 00 15

SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes limited scope general construction materials and methods, electrical equipment coordination, and common electrical installation requirements as follows:
 - 1. Access doors in walls, ceilings, and floors for access to electrical materials and equipment.
 - 2. Electrical equipment nameplate data.
 - 3. Sleeves and seals for electrical penetrations.
 - 4. Joint sealers for sealing around electrical materials and equipment, and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
 - 5. Sealing penetrations through noise critical spaces.

1.02 DEFINITIONS

- A. The following abbreviations apply to this and other Sections of these Specifications:
 - 1. AFF: Above Finished Floor
 - 2. AHJ: Authority(ies) having Jurisdiction
 - 3. ATS: Acceptance Testing Specifications
 - 4. EMT: Electrical Metallic Tubing
 - 5. EPDM: Ethylene-propylene-diene monomer rubber
 - 6. FMC: Flexible Metal Conduit
 - 7. GRS: Galvanized Rigid Steel Conduit
 - 8. IMC: Intermediate Metal Conduit
 - 9. LFMC: Liquidtight Flexible Metal Conduit
 - 10. LFNC: Liquidtight Flexible Nonmetallic Conduit
 - 11. MC: Metal Clad
 - 12. MFR: Manufacturer
 - 13. N/A: Not Available or Not Applicable
 - 14. NBR: Acrylonitrile-butadiene rubber
 - 15. NRTL: Nationally Recognized Testing Laboratory
 - 16. PCF: Pounds per Cubic Foot
 - 17. RAC: Rigid Aluminum Conduit
 - 18. RMC: Rigid Metal Conduit
 - 19. RNC: Rigid Nonmetallic Conduit
- B. The following definitions apply to this and other Sections of these Specifications:
 - 1. HOMERUN: That portion of an electrical circuit originating at a junction box, termination box, receptacle or switch with termination at an electrical panelboard. Note: Where MC Cable is utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first load.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 3. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.
 4. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate with general contractor to provide at least one path to outside with 8'-0" tall door in main electrical rooms and generator rooms that contain switchgear, motor control centers, generators and other electrical equipment taller than 6'-6".
- C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- D. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- E. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.04 NOISE CRITICAL SPACES

- A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces that will require application of sound attenuating measures and acoustical sealants.
1. Patient and Baby Care Areas
 2. Offices
 3. Consultation Rooms
 4. Operating Rooms
 5. Procedure Spaces
 6. Exam Rooms

1.05 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
1. Submit dimensioned layouts of electrical equipment locations within electrical rooms, generator rooms and fire pump rooms with equipment drawn to 1/4" scale and identified therein. Working clearance and access shall be clearly identified on the drawings. Rooms shall be designed, including door openings, and clearance shall be provided to allow for the future removal of each generator, unit substation transformer or other large piece of equipment independently without having to remove non-related equipment first.
 2. Product data for the following products:
 - a. Sleeve seals.
 - b. Through and membrane penetration firestopping systems.
 - c. Joint Sealers
 - d. Acoustical sealers
 3. Shop drawings for:
 - a. Detailed fabrication drawings of access panels and doors.
 4. Detailed list of proposed nameplates for Owner/Engineer review and acceptance before fabrication and attachment.
 5. Through and Membrane Penetration Firestopping Systems Product Schedule: Provide UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.

- a. Where Project conditions require modification to qualified testing and inspecting agency's illustrations for a particular firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
 - b. Qualifications Data for testing agency.
6. Record Drawings: Submit Record Drawings as required by Division 1 and Division 26
 - a. Accurately record actual locations of firestopped penetrations and access panel/door locations. Indicate dimensions from fixed structural elements.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.02 ACCESS TO EQUIPMENT

- A. Manufacturers:
 1. Bar-Co., Inc.
 2. Elmdor Stoneman.
 3. JL Industries
 4. Jay R. Smith Mfg. Co.
 5. Karp Associates, Inc.
 6. Milcor
 7. Nystrom Building Products
 8. Wade
 9. Zurn
- B. Access Doors:
 1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section "Identification for Electrical Systems" for labeling of access doors.
 2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
 3. Access doors must be of the proper construction for type of construction where installed.
 4. The exact location of all access doors shall be verified with the Contract Administrator prior to installation.
 5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
 6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
 - b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.

- c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
- 7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
- 8. Locking Devices: Flush, screwdriver-operated cam locks.

2.03 STEEL SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends and drip rings.

2.04 CAST IRON WALL PIPE SLEEVES FOR RACEWAYS AND CABLES

- A. Manufacturers
 - 1. Josam Mfg. Co.
 - 2. Smith (Jay R) Mfg. Co.
 - 3. Tyler Pipe/Wade Div.; Subs of Tyler Corp.
 - 4. Watts Industries, Inc.
 - 5. Zurn Industries, Inc.; Hydromechanics Div.
- B. Cast-iron sleeve with integral clamping flange with clamping ring, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.
- C. Sleeves for rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138- inch thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with selection and application of firestopping to be used.

2.05 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Contract Administrator from manufacturer's standard colors.
- C. Elastomeric Joint Sealers: Provide the following types:
 - 1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.
 - 2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.
 - 3. Products: Subject to compliance with requirements, provide one of the following:
 - a. One-Part, Nonacid-Curing, Silicone Sealant:
 - 1) "Dow Corning 790," Dow Corning Corp.
 - 2) "Dow Corning 795," Dow Corning Corp.
 - 3) "Silglaze N SCS 2801," General Electric Co.
 - 4) "Silpruf SCS 2000," General Electric Co.
 - 5) "864," Pecora Corp.
 - 6) ".Omniseal," Sonneborn Building Products Div
 - 7) "Spectrem 1," Tremco, Inc.
 - 8) "Spectrem 2," Tremco, Inc.
 - b. One-Part, Mildew-Resistant, Silicone Sealant:

- 1) "Dow Corning 786," Dow Corning Corp.
 - 2) "Sanitary 1700," General Electric Co.
 - 3) "898 Silicone Sanitary Sealant," Pecora Corp.
 - 4) "OmniPlus," Sonneborn Building Products Div.
 - 5) "Tremsil 600 White," Tremco Corp.
- D. Acrylic-Emulsion Sealants: One-part, non-sagging, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Chem-Calk 600," Bostik
 - b. "AC-20," Pecora Corp.
 - c. "Sonolac," Sonneborn Building Products Div.
 - d. "Tremflex 834," Tremco, Inc.

2.06 FIRESTOPPING

- A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, by Underwriters' Laboratories, Inc., or other NRTL acceptable to AHJ.
1. Manufacturers:
 - a. Hilti, Inc.
 - b. RectorSeal.
 - c. Specified Technologies Inc.
 - d. 3M Corp.
 - e. United States Gypsum Company.

2.07 ACOUSTICAL SEALANTS

- A. Foam Backer Rod: Closed cell polyethylene suitable for use as a backing for non-hardening sealant.
- B. Non-Hardening Penetration Sealant: Non-hardening polysulphide type. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.
- C. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 PCF (40 kg/m3).

PART 3 - EXECUTION

3.01 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".
- B. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)
- C. Comply with NECA 1.
- D. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless indicated otherwise.
- E. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

- F. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- G. Right of Way: Give to raceways and piping systems installed at a required slope.

3.02 ACCESS DOORS

- A. Furnish adequately sized access doors for the devices served, with a minimum size of 18 inches x 18 inches, for installation under Division 09 "Finishes".
- B. Furnish access doors of the proper construction for type of ceiling or wall construction where installed.
- C. Verify the exact location, sizes, and types of all access doors with the Contract Administrator prior to purchase.
- D. Provide access doors for all concealed electrical equipment, except where above lay-in ceilings.
- E. Coordinate with architectural finishes to set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- F. Adjust hardware and panels after installation for proper operation.
- G. Label all access doors with a nameplate as described in Division 26 Section "Identification for Electrical Systems".

3.03 SLEEVES AND SLEEVE SEALS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Provide all sleeves for required openings in all concrete and masonry construction and fire, smoke, or both, partitions, for all electrical Work that passes through such construction. Coordinate with all other trades and Divisions to dimension and lay out all such openings.
- C. Only those openings specifically indicated on the Architectural or Structural Drawings will be provided under other Divisions.
- D. Construction in Existing Facilities:
 - 1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Contract Administrator, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Contract Administrator.
- E. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls. Do not cut or core drill new construction without written approval from the Contract Administrator and Structural Engineer.
- F. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- G. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
 - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
- H. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- I. Install pipe and rectangular sleeves in above-grade walls and slabs, where penetrations are not subject to hydrostatic water pressures. Ensure that drip ring is fully encased and sealed within the wall or slab.
- J. Cut sleeves to length for mounting flush with both surfaces of walls.
- K. Extend sleeves installed in floors 2 inches above finished floor level.

- L. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed; in which case, size sleeves as recommended by the seal manufacturer.
- M. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- N. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint
- O. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.
- P. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (or larger, if required by the seal manufacturer) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- Q. Above Grade Concrete or Masonry Penetrations
 - 1. Provide sleeves for cables or raceways passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:
 - a. Install schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
 - b. Install galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 0.138 inches.
 - c. Install galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:
 - 1) For sleeve cross-section rectangle perimeter 50 inches and no side greater than 16 inches, thickness shall be 0.52 inches.
 - 2) For sleeve cross-section rectangular perimeter equal to, or greater than, 50 inches and one (1) or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inches.
 - d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.
 - 2. Seal elevated floor, exterior wall and roof penetrations watertight and weather tight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of 1/2" of sealant.
- R. Interior Foundation Penetration: Provide sleeves for horizontal raceway passing through or under foundation. Sleeves shall be cast iron soil pipe two normal pipe sizes larger than the pipe served.
- S. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and cable or raceway, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2" of sealant.
- T. Sleeve-Seal Installation
 - 1. Install sleeve seals for all underground raceway penetrations through walls at elevations below finished grade. Additionally, install seals inside raceways, after conductors or cables have been installed, in all raceway penetrations through walls at elevations below finished grade.
 - 2. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- U. Inspect installed sleeve and sleeve-seal installations for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade and above grade where installed to seal against hydrostatic pressure.

3.04 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire/smoke-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.05 JOINT SEALERS

- A. Preparation for Joint Sealers
 - 1. Clean surfaces of penetrations, sleeves, or both, immediately before applying joint sealers, to comply with recommendations of joint sealer manufacturer.
 - 2. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.
- B. Application of Joint Sealers
 - 1. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - a. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - b. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
 - 2. Tooling: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
- C. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical raceways penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.06 ACOUSTICAL PENETRATIONS

- A. Do not allow direct contact of raceways with shaft walls, floor slabs and/or partitions. Sleeve, pack and seal airtight with foam rod, non-hardening sealant and/or packing material, as described herein, for all penetrations by raceway, through surfaces that encompass or are between noise critical spaces. Seal and pack with caulking for the full depth of the penetration all openings around raceways in the structure surrounding the electrical equipment and surrounding noise-critical spaces. This includes all slab penetrations and penetrations of noise critical walls.
- B. Where a raceway passes through a wall, ceiling or floor slab of a noise critical space, cast or grout a metal sleeve into the structure. The internal diameter or dimensions of the sleeve shall be 2 inches larger than the external diameter or dimensions of the raceway passing through it. After all of the raceways are installed in that area, check the clearances and correct, if necessary, to within 1/2-inch. Pack the voids full depth with packing material sealed at both ends, 1-inch deep, with non-hardening sealant backed by foam rod.

END OF SECTION 26 05 00

SECTION 26 05 02 EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes limited scope for electrical connections to equipment specified under other Sections or Divisions, or furnished under separate contracts or by the Owner.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Unless otherwise noted, perform all electrical Work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.
- B. Coordinate with work described in Division 22 Section "Medical Gas Systems".
- C. Coordinate with work described in 23 Section, "Common Work Results for HVAC".
- D. Coordinate with work described in Division 23 Section "Direct-Digital Control for HVAC".
- E. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.
- F. Determine connection locations and rough-in requirements based on Shop Drawings.
- G. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.
- H. Sequence electrical connections to coordinate with start-up schedule for equipment.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Product data for the following products for:
 - a. Special connectors
 - b. Special conductors or cable assemblies
 - 2. Shop drawings for:
 - a. Detailing electrical characteristics, wiring diagrams, fabrication and installation for wiring systems.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.01 CORDS AND CAPS

- A. Attachment Plugs: Conform to NEMA WD 1.
- B. Configuration: NEMA WD 6, matching receptacle configuration at outlet provided for equipment, or as required by the equipment manufacturer.
- C. Cord: See Paragraph "Flexible Cords" in Division 26 Section "Low-voltage Electrical Power Conductors and Cables".

- D. Provide cord size suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify conditions of equipment and installation prior to beginning work.
- B. Verify that equipment is ready for connecting, wiring, and energizing.

3.02 INSTALLATION, GENERAL

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

3.03 ELECTRICAL DEVICES

- A. Install disconnect switches, controllers, control stations, and control devices (other than temperature control devices) as indicated.
- B. Install disconnect switches, controllers, control stations, and control devices (other than temperature control devices) specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

3.04 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturers' instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.
- C. Make wiring connections using conductors and cable with insulation suitable for temperatures encountered in heat producing equipment.
- D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated on the Drawings.
- E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- F. Provide interconnecting conduit and wiring between devices and equipment where indicated on the Drawings.

3.05 HVAC EQUIPMENT

- A. When equipment is delivered in separate parts and field assembled, internal wiring, indicated on Shop Drawings as field wiring, will be provided by the equipment supplier, unless otherwise noted.
- B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.
- C. Provide all control and interlock wiring for all equipment that is not included within the responsibility of Division 22 or 23.

3.06 DOOR OPERATORS AND HARDWARE

- A. Provide electrical connections to automatic entry doors, automatic corridor doors, electrically held door latches, remote release doors, and all other required electrical connections for door systems included in other sections of these specifications.
- B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.
- C. Provide all control wiring and conduit for all equipment that is not included within the responsibility of the door hardware installer. Provide connection from junction boxes to the door operators or hardware and from door operators to actuation devices as required. Install key operated switches, push pad switches, and other electrically controlled door operation devices furnished by other divisions within this contract.

- D. Provide fire alarm devices and wiring as required for proper operation of door systems in accordance with the NFPA codes.

3.07 MEDICAL GAS SYSTEMS

- A. All connections associated with the medical gas system shall be made in accordance with NFPA 99 – Standard for Healthcare Facilities.
- B. Provide power connection to all equipment as indicated or as otherwise required to accommodate the equipment indicated in the medical gas system drawings and specifications.
- C. Provide all raceways, conduit, back boxes and cabling for all control wiring required to accommodate the equipment indicated in the medical gas system drawings and specifications, that is not indicated as being within the responsibility of the equipment installer.
- D. Provide all grounding systems as required by the equipment supplier.

3.08 MEDICAL EQUIPMENT

- A. Provide all work related to Division 26 required for the Owner furnished medical equipment. Note that this work has not been entirely duplicated and indicated on the sheets with E prefixes, rather only a minimum amount as required for coordination with other systems, and as required to comply with local codes. The medical equipment planner has prepared a complete manual including all the equipment intended to be purchased general electrical requirements and associated cut sheets. Review the medical equipment manual prior to bid. Prior to rough-in and final connection coordinate with final equipment installation diagrams, drawings, manuals, and specifications. Such equipment may include but shall not be limited to the following: mobile x-ray equipment, surgical or exam lights, articulating arms, equipment booms, headwalls, patient beds, patient lift systems, processors, sterilizers, warming cabinets, refrigerators, freezers, blood bank equipment, laboratory equipment, x-ray film view boxes, digital x-ray viewing systems, or bio-medical patient monitoring systems.
- B. Provide power connection to all equipment as indicated or as otherwise required to accommodate the medical equipment.
- C. Provide all grounding systems as required by the equipment supplier.
- D. Provide wireways, cable trays, trench duct, wall duct, conduit and all other raceways and boxes as required to accommodate the medical equipment that is not indicated as being within the responsibility of the equipment installer.
- E. Provide all other equipment, wiring, connections, emergency power off stations, warning lights, interlocks, controls, etc. as required to accommodate the medical equipment that is not indicated as being within the responsibility of the equipment installer.

3.09 DIAGNOSTIC AND THERAPEUTIC MEDICAL IMAGING EQUIPMENT

- A. Provide all work related to Division 26 required in the medical equipment installation drawings. Note that this work has not been entirely duplicated and indicated on the sheets with E prefixes, rather only a minimum amount as required for coordination with other systems, and as required to comply with local codes. Typically the medical equipment installation drawings are attached to the construction drawing set, however some vendors issue a separate installation manual in book format. Review all medical equipment installation drawings, manuals, and specifications prior to bid and rough-in. Such equipment may include but shall not be limited to the following: x-ray equipment, catheterization lab equipment, linear accelerator equipment, simulator equipment, CT scan equipment, MRI equipment, surgical room lights and equipment, and other diagnostic and therapeutic equipment.
- B. Provide power connection to all equipment as indicated or as otherwise required to accommodate the medical equipment.
- C. Provide all grounding systems as required by the equipment supplier.
- D. Provide wireways, cable trays, trench duct, wall duct, conduit and all other raceways and boxes as required to accommodate the medical equipment that is not indicated as being within the responsibility of the equipment installer.

- E. Provide all other equipment, wiring, connections, emergency power off stations, warning lights, interlocks, controls, etc. as required to accommodate the medical equipment that is not indicated as being within the responsibility of the equipment installer.

3.10 SMOKE EVACUATION

- A. Life Safety feeders shall be installed in fire rated enclosures or shall be constructed as a rated assembly per NEC700 and IBC 403.
- B. Life Safety feeders shall not be routed in the same enclosures as other feeder types except as permitted by NEC 700.
- C. Life Safety loads shall be as defined by NEC 700 and IBC 403 including but not limited to the following:
 - 1. Egress Lighting
 - 2. Smoke Evacuation Fans
 - 3. Stair Pressurization Fans
 - 4. Atrium Ventilation Fans

END OF SECTION 26 05 02

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes:
 - 1. Conductors, cables, and cords rated 600V and less.
 - 2. Connectors and terminations rated 600V and less.

1.02 DEFINITIONS

- A. The following abbreviations apply to this and other Sections of these specifications:
 - 1. MC: Metal Clad
 - 2. NBR: Acrylonitrile-butadiene rubber
- B. The following definitions apply to this and other Sections of these Specifications:
 - 1. HOMERUN: That portion of an electrical circuit beginning at a junction box, termination box, receptacle or switch with termination at an electrical panelboard. Note: Where MC Cable is allowed to be utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first (most upstream) load.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.04 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Product data for the following products:
 - a. Conductors, cables, and cords rated 600V and less
 - b. Metal clad – Health Care Facility (MC-HCF) and fittings.
- B. Qualification Data: For testing agency.
- C. Field Quality-Control Test Reports:
 - 1. Submit all system and component test results.

1.05 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."
- C. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
- D. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
 - 2. Marked for intended use.
- E. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.02 CONDUCTORS AND CABLES

- A. General
 - 1. Manufacturers:
 - a. AFC Cable Systems, Inc.
 - b. Alan Wire
 - c. Cerrowire
 - d. Colonial Wire & Cable
 - e. Encore Wire Corporation
 - f. General Cable
 - g. Northern Cables Inc.
 - h. Okonite Company
 - i. Southwire Company
 - 2. Conductor Material: Annealed (soft) copper complying with ICEA S-95-658/NEMA WC70 and UL Standards 44 or 83, as applicable;
 - a. Stranded conductors
 - b. Solid conductors for No. 10 AWG and smaller; concentric, compressed stranded for No. 8 AWG and larger
 - c. Stranded for all flexible cords, cables, and control wiring
 - d. As noted otherwise below
 - 3. Aluminum conductors are not allowed.
 - 4. Conductor Insulation: Complying with ICEA S-95-658/NEMA WC70 use Type:
 - a. THW
 - b. THHN/THWN-2
 - c. XHHW-2
 - 5. Sizes of conductors and cables indicated or specified are American Wire Gage (Brown and Sharpe).
 - 6. Unless indicated otherwise, special purpose conductors and cables, such as low voltage control and shielded instrument wiring, shall be as recommended by the system equipment manufacturer.
 - 7. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

2.03 SINGLE CONDUCTORS

- A. 600V, insulated conductors as noted above shall be color-coded as follows:

PHASE	120/240V	240Δ/120V	208Y/120V	480Y/277V
A	Black	Black	Black	Brown
B	Red	Orange	Red	Orange
C	N/A	Red	Blue	Yellow
Neutral	White	White	White	Gray**
Equipment Ground	Green	Green	Green	Green
Isolated Ground	N/A	N/A	Green/Yellow Stripe	N/A

**Except as provided in NFPA 70.

- B. Conductors shall not be smaller than No. 12 AWG, except that wiring for signal and pilot control circuits and pre-manufactured whips for light fixtures may be No. 14 AWG.

2.04 METAL CLAD CABLE, TYPE MC

A. General

1. Metal Clad Cable, Type MC (for non-patient care areas only. Do not use for life safety or critical systems.)

B. MC Cable (with insulated green grounding conductor, no bonding conductor):

1. Manufacturers:
 - a. AFC Cable Systems, Inc. (MC Lite)
 - b. Encore Wire Corporation (MC)
 - c. Kaf-Tech
 - d. Southwire Company (Amorlite)
2. 600V, Unjacketed and/or PVC-jacketed UL Standard 83, UL Standard 1569 for Type MC, UL Standard 1685, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and the NEC. Type MC Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.
3. Armor Assembly: Aluminum interlocked armor (aluminum color).
4. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1.
5. Grounding Conductor: Solid soft-drawn copper, THHN/THWN-2 green insulated grounding conductor sized per NEC Table 250.122.
6. Marking: Cable markings shall comply with the requirements on NEC ART. 310.11.

C. MC Cable (with 0-10V dimming control wiring):

1. Manufacturers:
 - a. AFC Cable Systems, Inc. (MC- PCS)
 - b. Encore Wire Corporation (MC- LED)
 - c. Southwire Company (MC – PCS Duo)
2. 600V, Unjacketed and/or PVC-jacketed UL Standard 83, UL Standard 1569 for Type MC, UL Standard 1685, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and the NEC. Type MC Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.
3. Armor Assembly: Aluminum interlocked armor (aluminum color).
4. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1.
5. Grounding Conductor: Solid soft-drawn copper, THHN/THWN-2 green insulated grounding conductor sized per NEC Table 250.122.
6. Control Conductors: color coded class2/class3 twisted jacketed pairs

7. Marking: Cable markings shall comply with the requirements of NEC Art 310 .11(1).
- D. MC Cable Fittings:
 1. Manufacturer & Model:
 - a. Arlington (4010 AST snap-in type): (SG38 saddle type)
 - b. Crouse-Hinds (QLK Quick-Lok Series, Saddle type); ACB Series; set-screw, saddle type)
 - c. O-Z Gedney (AMC-50 speed-lok, saddle type)
 - d. Thomas & Betts (XC-730 Series cable-lok, saddle type); 3110 Series Tite-Bite)
 2. Fittings used for connecting Type MC cable to boxes, cabinets, or other equipment shall be UL listed and identified for such use with an MCI-A marking on the fitting carton or package.
 3. Fittings shall be insulated type not requiring the use of anti-short bushings.
 4. Romex style, clamp type fittings are not acceptable.

2.05 METAL CLAD CABLE – HEALTH CARE FACILITY RATED TYPE MC- HCF

- A. General
 1. Use allowed for normal power circuits in general patient care areas.
 2. Do not use for life safety or critical systems.
- B. Metal Clad Cable – Health Care Facility Rated Type MC- HCF: (use allowed for normal power circuits in general patient care areas. Do not use for life safety or critical systems).
 1. Manufacturers:
 - a. AFC Cable Systems, Inc. (MC- Stat)
 - b. Encore Wire Corporation (MC- MCMP)
 - c. Southwire Company (HCF – MCAP)
 2. 600V, Unjacketed and/or PVC-jacketed UL Standard 1569 for Metal-Clad cables, UL Standard 83, UL Standard 1063, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and the NEC. MC cable shall be listed for use in UL 1, 2, and 3 Hour through-Penetration Firestop Systems.
 3. Armor Assembly: Aluminum interlocked armor and full-sized solid bare aluminum grounding/bonding conductor in intimate and continuous contact with armor – recognized as equipment ground per NEC Articles 250.118 and 517.13(A).
 4. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1.
 5. Grounding Conductor: Solid, soft-drawn copper, THHN green insulated grounding conductor sized per NEC 517.13(B) and Table 250.122.
 6. Type MC-HCF Cable shall be “Hospital Care Facility” type in accordance with NEC section 517.13 with raceway system listed as an equipment ground return path.
 7. Marking: Cable markings shall comply with the requirements of NEC Art 310 .11(1). Outer armor shall have green-color for easy identification as hospital patient care rated.
- C. MC – HCF Cable (with 0-10V dimming control wiring):
 1. Manufacturers:
 - a. AFC Cable Systems, Inc. (MC- HCF-PCS)
 - b. Encore Wire Corporation (MC- HCF-PCS)
 - c. Southwire Company (MC-HCF-PCS Duo)
 2. 600V, Unjacketed and/or PVC-jacketed UL Standard 1569 for Metal-Clad cables, UL Standard 83, UL Standard 1063, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and the NEC. MC cable shall be listed for use in UL 1, 2, and 3 Hour through-Penetration Firestop Systems.

3. Armor Assembly: Aluminum interlocked armor and full-sized solid bare aluminum grounding/bonding conductor in intimate and continuous contact with armor – recognized as equipment ground per NEC Articles 250.118 and 517.13(A).
 4. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1.
 5. Control Conductors: color coded class2/class3 twisted jacketed pairs
 6. Grounding Conductor: Solid, soft-drawn copper, THHN green insulated grounding conductor sized per NEC 517.13(B) and Table 250.122.
 7. Type MC-HCF Cable shall be "Hospital Care Facility" type in accordance with NEC section 517.13 with raceway system listed as an equipment ground return path.
 8. Marking: Cable markings shall comply with the requirements of NEC Art 310.11(1). Outer armor shall have green-color for easy identification as hospital patient care rated.
- D. MC Cable Fittings:
1. Manufacturer & Model:
 - a. Arlington (4010 AST snap-in type): (SG38 saddle type)
 - b. Crouse-Hinds (QLK Quick-Lok Series, Saddle type); ACB Series; set-screw, saddle type)
 - c. O-Z Gedney (AMC-50 speed-lok, saddle type)
 - d. Thomas & Betts (XC-730 Series cable-lok, saddle type); 300 Series Tite-Bite).
 2. Fittings used for connecting Type MC cable to boxes, cabinets, or other equipment shall be UL listed and identified for such use with an MCI-A marking on the fitting carton or package.
 3. Fittings shall be insulated type not requiring the use of anti-short bushings.
 4. Romex style, clamp type fittings are not acceptable.

2.06 FLEXIBLE CORDS

- A. 600V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant black or yellow jacket, extra-hard-usage; Type SEO, SO, or STO for indoor dry and damp locations; SEOW, SOW, or STOW for damp, wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.
- B. 300V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant black or yellow jacket, hard-usage; Type SJEO, SJO, or SJTO for indoor dry locations; SJEOW, SJOW, or SJTOW for damp, wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.

2.07 CONTROL WIRING

- A. Refer to Division 23 Section "Direct-Digital Control for HVAC"
- B. Unless otherwise noted, all control wiring will be the responsibility of the Section or Division in which the control system is specified.

2.08 CONNECTORS

- A. Manufacturers:
 1. AMP; Tyco
 2. FCI-Burndy
 3. Gould
 4. Ideal Industries, Inc.
 5. IlSCO
 6. NSI Industries, Inc.
 7. O-Z/Gedney
 8. Panduit

- 9. Thomas and Betts
- 10. 3-M Electrical Products Division
- B. Compression connectors for conductors No. 8 AWG and larger: Long-barreled, UL 486-listed, circumferential compression type (Burndy "Hylug", or equal), insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.
 - 1. Termination fittings for copper conductors: bare copper, 1-hole pad and inspection port.
- C. Mechanical connections for conductors No. 8 AWG and larger: UL-listed, dual-rated, mechanical type, insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.
 - 1. Termination fittings: bare copper, 1-hole pad.
- D. Connectors for solid conductors No. 10 AWG and smaller: Insulated winged wire nuts. Color-coded for size, except use green only for grounding connections.
- E. Connectors for stranded conductors No. 10 AWG and smaller: Tinned copper, insulated-sleeve, compression type, UL-listed, with wire insulation grip.
 - 1. Terminations:
 - a. Flanged fork-tongue type
 - b. Ring-tongue type
- F. Connectors and terminations for aluminum conductors and cables No. 1 and larger: UL 486B listed and marked AL7CU for 75 deg C rated conductors and AL9CU for 90 deg C rated conductors.

PART 3 - EXECUTION

3.01 PREPERATION

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".
- B. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)
- C. Electrical conductor and cable work is schematically represented on the Drawings. Unless otherwise indicated, conductor sizes shown on the Drawings are based on not more than three single current-carrying conductors in a raceway in free air. Current ratings are based on copper at 75 degrees C temperature rating for all power circuits. Modify raceway and conductor sizing as may be necessitated by any deviation from these conditions. Do not decrease the indicated conductor size due to the use of conductors having a temperature rating of 90 degrees C.
- D. Conductor sizes shown are minimum based on code requirements, voltage drop, and/or other considerations. Where approved by the Engineer and at no extra cost to the Owner, larger conductor sizes may be installed at Contractor's option in order to utilize stock sizes, provided raceway sizes are increased where necessary to conform with NFPA 70 (determine the effect of the use of larger conductors on the short circuit current ratings of the electrical equipment, and provide increased short circuit current rated equipment as required).

3.02 INSTALLATION

- A. General
 - 1. Install in accordance with manufacturer's instructions.
 - 2. Unless otherwise indicated on the Drawings or in other Sections, install all conductors in raceway. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 12 inches of conductor at outlets for fixture or device connections.

3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used shall not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 4. Use pulling means, including fish tape, cable, rope, and basket weave conductor/cable grips that will not damage conductors/cables or raceway.
 5. Where parallel conductors are shown, install each set of conductors in separate raceways of essentially the same length.
 6. Wiring at Outlets: Install conductors at each outlet with at least 12 inches of slack.
 7. Common or Shared Neutrals are not allowed unless shown on the plans or specifically noted to be allowed.
 8. Multi-wire branch circuits (i.e., shared neutral) shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point the branch circuit originates. Multi-pole breakers or 3 single pole breakers with a handle tie are two example
 9. When multiple home runs are combined into a single raceway such that the number of conductors exceeds four (conductor count is made up of any combination of phase and neutral conductors), the following restrictions apply, which are in addition to those in NFPA 70:
 - 1) Maximum of eight conductors in a single raceway. Minimum raceway size: $\frac{3}{4}$ -inch. Do not install any other type of circuit in this raceway.
 - 2) Only 15A and 20A branch circuit homeruns may be combined into one raceway.
 - a. Emergency Power Circuits – includes all circuits covered under Articles 700, 701 and 702.
 - b. Healthcare Critical branch circuits as defined in Article 517.
 - c. GFCI-protected circuits.
 - 3) Do not use multi-conductor circuits, with a shared neutral, for any GFCI circuit breaker or receptacle circuit.
 - 4) Do not use multi-conductor or MC cables.
 - 5) Do not share neutrals between separate circuits.
 10. For branch circuits fed from GFCI circuit breakers, limit the one-way conductor length to 100 feet between the panelboard and the most remote receptacle or load on the GFCI circuit.
 11. Where the number of conductors for branch circuits is not shown on the Drawings, determine the number of conductors in accordance with NFPA 70. Provide adequate conductors so as to allow performance of all functions of the device.
 12. Provide all conductors with 600V insulation of the following types, unless otherwise noted on the Drawings or in these Specifications:
 - a. Wet or dry locations, in raceways:
 - 1) Service entrance: Type THWN, THHN/THWN-2, or XHHW.
 - 2) Feeders and branch circuits: Type THWN, THHN/THWN-2, or XHHW.
 - 3) Conductors No. 6 AWG and smaller: Types THWN or THHN/THWN-2.
 - 4)
 - 5) Feeders and branch circuits: UF or USE.
- B. Metal Clad Type MC and/or Metal Clad Health Care Facility type MC-HFC Cable:
1. Securing and Supporting:
 - a. Support per Art 330 for MC cable
 - b. Secure cable within 12 inches of every box or fitting.
 - c. Secure/supporting intervals shall not exceed six (6) feet for MC cable.

- d. Utilize steel cable hangers, Arlington SMC series or equivalent, for MC cable support wherever possible so as to provide for cable routing in a neat and workmanship like manner.
- 2. Type MC and/or MC-HCF cable may only be used:
 - a. In lieu of flexible conduit and wiring from light fixtures in accessible ceilings to junction boxes (attached to building structure) above the ceiling. Provide cable whips of sufficient lengths to allow for relocating each light fixture within a 5-foot radius of its installed location, but not exceeding 6 feet in unsupported lengths.
 - b. For vertical drops and horizontal wiring in stud walls.
 - c. In lieu of metal raceway, only for 15A and 20A branch circuits with up to four (4) conductors, not including grounding and/or bonding conductor(s), and only in dry concealed locations above grade, except where specifically not permitted by the NEC.
- 3. MC and/or MC-HCF cable shall not be used for any use not listed in the paragraph above. Examples of those uses include, but are not limited to:
 - a. Unjacketed MC and/or HCF
 - 1) In locations not permitted by the NEC.
 - 2) When specifically not allowed by the local AHJ or Owner.
 - 3) Homeruns to panelboards. Note: where metal clad cable is utilized for receptacle, lighting, and/or miscellaneous load branch circuiting, the originating point of the homerun shall be at the first (most upstream) load in the circuit or at a junction box located in the accessible ceiling space immediately above the first (most upstream) load. Reference definitions in this section for definition on "Homerun".
 - 4) Where exposed to view.
 - 5) Where subject to physical damage.
 - 6) Corrosive or Hazardous locations.
 - 7) Wet locations.
 - 8) Emergency systems (life safety and critical branches) of Health Care facilities accept as allowed by Art 517.30(C)(3).
 - 9) Emergency circuits covered by NFPA Art 700 Emergency Systems
 - b. PVC Jacketed MC and/or HCF
 - 1) In locations not permitted by the NEC.
 - 2) When specifically not allowed by the local AHJ or Owner.
 - 3) Homeruns to panelboards. Note: where metal clad cable is utilized for receptacle, lighting, and/or miscellaneous load branch circuiting, the originating point of the homerun shall be at the first (most upstream) load in the circuit or at a junction box located in the accessible ceiling space immediately above the first (most upstream) load. Reference definitions in this section for definition on "Homerun".
 - 4) Where subject to physical damage.
 - 5) Emergency circuits covered by NFPA Art 700 Emergency Systems
- 4. Type MC- HCF cable shall have an outer metal armor or sheath in accordance with NEC Art 517.13(A). This requirement applies to MC- HCF cable installations for non-emergency (non-life safety & non-critical) circuits in General Patient Areas i.e. Patient bedrooms, examining rooms, treatment rooms, clinics, and similar areas within health care facilities including but not limited to, hospitals, nursing homes, limited care facilities, clinics, medical and dental offices, and ambulatory care centers, whether permanent or movable.
 - a. This further applies to any area where it is intended that the patient will come in contact with ordinary appliances such as a nurse call system, electric instrument, cord

connected equipment, electric beds, examining lamps, telephones, and entertainment devices.

- b. Type MC- HCF Health Care Facility cable is permitted for use in general patient care areas of health care facilities. The use of standard/non-health care facility type MC or AC cable is not permitted in patient care areas.
- c. The HCF length for power circuits shall be limited to 30 feet from the junction box to the wiring device located in the wall. If the circuit continues outside the wall, the circuit shall immediately transition to conduit.
- d. The HCF length for lighting circuits shall be limited to 30 feet from the junction box to the first fixture and from that point only those fixtures above the enclosed space/room shall be served by this HCF circuit.

C. Flexible Cords

- 1. Refer to Division 26 Section, "Equipment Wiring Systems", for electrical connections to equipment.

D. Control Wiring

- 1. Unless otherwise indicated on the Drawings or in other sections, install all control wiring in raceway, regardless of voltage. A qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.
- 2. Open wiring in air-handling plenums: UL listed and classified for use in air plenums without raceway. Where indicated on the Drawings or specified, and permitted by local codes, only cable for communication or fire alarm systems and low voltage control wiring may be installed without raceways.
- 3. Low voltage wiring not routed in a race way shall be supported by cable tray or j-hooks secured independently of ceiling supports. Cabling shall not be supported directly by the ceiling system.

E. Connections:

- 1. Apply a zinc based, anti-oxidizing compound to connections.
- 2. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- 3. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- 4. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- 5. Use only resin pressure splices and splicing kits that totally encapsulate the splice for splices in underground junction boxes. Arrange the splicing kit to minimize the effects of moisture.
- 6. Use connectors as indicated in equipment schedules. Where not indicated use connections as noted below.
 - a. Compression – Conductors No. 8 AWG and larger to panelboards, switchboards and apparatus
 - b. Compression – splices, terminals
 - c. Mechanical – where temporary removal is required
- 7. Do not use terminals on wiring devices to feed through to the next device.

3.03 IDENTIFICATION

- A. General: Provide all identification per Division 26 "Identification for Electrical Systems".
- B. Single Conductors: Identify and color-code conductors to indicate voltage and phase according to Part 2 of this Section. Identification method shall be either:
 - 1. Factory provided colored insulation

2. Color-Coding Conductor Tape.
 3. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- C. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in the same junction or pull box identify each ungrounded conductor according to source and circuit number.
- E. Conductors to Be Extended in the Future: Attach identification device to conductors and list source and circuit number.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- G. Conductors for controls (lighting, controls): Label each conductor with Markers for Conductor and Control Cables. – identify conductors using method as noted in Division 26 Section "Identification for Electrical Systems". Note conductor identification on record Drawings.
- H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
- I. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.04 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements. Test all wiring prior to energizing to ensure that it is free from unintentional grounds and shorts, is properly phased, and that all connectors are tight.
 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3. Certify compliance with test parameters.
- B. Test Reports: Prepare a written report to record the following:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
- B. This Section includes:
 - 1. Grounding Conductors
 - 2. Connector Products
 - 3. Miscellaneous Grounding Materials and Products

1.02 DEFINITIONS

- A. The following apply to this and other Sections of these Specifications:
 - 1. EMT: Electrical metallic tubing.
 - 2. ENT: Electrical nonmetallic tubing.
 - 3. FMC: Flexible metal conduit.
 - 4. IMC: Intermediate metal conduit.
 - 5. LFMC: Liquidtight flexible metal conduit.
 - 6. LFNC: Liquidtight flexible nonmetallic conduit.
 - 7. RMC: Rigid Metal Conduit
 - 8. GRS: Galvanized Rigid Steel Conduit
 - 9. RAC: Rigid Aluminum Conduit
 - 10. RNC: Rigid nonmetallic conduit.
 - 11. PSF: Pounds per Square Foot

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Product data for the following products:
 - a. Mechanical and compression connectors, and exothermic connectors.
- B. Qualification Data: For a qualified testing and inspecting agency engaged by Contractor.
- C. Quality-Control Test Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Accurately record actual locations of all exterior buried electrodes and all buried ground rings. Indicate dimensions from fixed structural elements.

1.04 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Test Equipment Suitability and Calibration: Comply with NETA ATS (current version), "Suitability of Test Equipment" and "Test Instrument Calibration."

- C. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- D. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.
 - 3. Comply with UL 467.
- E. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.02 GROUNDING CONDUCTORS AND CONNECTORS:

- A. Manufacturers:
 - 1. Apache Grounding/Erco Inc.
 - 2. Boggs, Inc.
 - 3. Chance/Hubbell.
 - 4. Copperweld Corp.
 - 5. Dossert Corp.
 - 6. Erco Inc.; Electrical Products Group.
 - 7. FCI/Burndy Electrical.
 - 8. Galvan Industries, Inc.
 - 9. Harger Lightning Protection, Inc.
 - 10. Hastings Fiber Glass Products, Inc.
 - 11. Heary Brothers Lightning Protection Co.
 - 12. Ideal Industries, Inc.
 - 13. ILSCO.
 - 14. Kearney/Cooper Power Systems.
 - 15. Korns: C. C. Korns Co.; Division of Robroy Industries.
 - 16. Lightning Master Corp.
 - 17. Lyncole XIT Grounding.
 - 18. O-Z/Gedney Co.; a business of the EGS Electrical Group.
 - 19. Panduit, Inc
 - 20. Raco, Inc.; Division of Hubbell.
 - 21. Robbins Lightning, Inc.

- 22. Salisbury: W. H. Salisbury & Co.
- 23. Superior Grounding Systems, Inc.
- 24. Thomas & Betts, Electrical.

2.03 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables"
- B. Material:
 - 1. Copper.
- C. Equipment Grounding Conductors: Insulated and identified as indicated in Part 3 of this section.
- D. Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.
- E. Bare Copper Conductors:
 - 1. Solid Conductors: Comply with Conductors: ASTM B 8.
 - 2. Tinned Conductors: Comply with ASTM B 33.
- F. Copper Bonding Conductors:
 - 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 - 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (wide and 1/16 inch thick.
- G. Ground Conductor and Conductor Protector for Wood Poles: As follows:
 - 1. No. 4 AWG minimum, soft-drawn copper conductor.
 - 2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir, or cypress or cedar.

2.04 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors
 - 1. Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:
 - a. Company symbol and/or logo.
 - b. Catalog number.
 - c. Conductors accommodated.
 - d. Installation die index number or die catalog number is required.
 - e. Underwriters Laboratories "Listing Mark:".
 - f. The words "Suitable for Direct Burial" or, where space is limited, "Direct Burial" or "Burial" per UL Standard ANSI/UL467 (latest revision).
 - 2. Cast connectors: copper base alloy according to ASTM B 30 (latest revision).
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which electrical grounding connections are to be made and notify the Contract Administrator and the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. GENERAL

- 1. Provide all materials, labor and equipment for an electrical grounding system in accordance with applicable portions of the NEC and NECA. Coordinate electrical work as necessary to interface installation of electrical grounding systems with other work.
- 2. Accomplish grounding and bonding of electrical installations and specific requirements for systems, circuits and equipment required to be grounded for both temporary and permanent construction.
- 3. Where the size of the grounding conductors are not shown, size in accordance with NFPA 70 Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. APPLICATION

- 1. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- 2. In branch circuit and feeder raceways, use insulated equipment grounding conductors.
- 3. Equipment Grounding Conductors
 - a. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
 - b. Install equipment grounding conductors in all feeders and branch circuits.
 - c. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NFPA 70:
 - 1) Feeders and branch circuits.
 - 2) Lighting circuits.
 - 3) Receptacle circuits.
 - 4) Single-phase motor and appliance branch circuits.
 - 5) Three-phase motor and appliance branch circuits.
 - 6) Flexible raceway runs.
 - 7) Armored and metal-clad cable runs.
 - 8) Feeders and branch circuits installed in non-metallic raceways.
- 4. Separately Derived Systems: Bond the derived neutral (grounded) conductor of all separately derived system (e.g., transformers, generators, UPS) to the nearest available grounding electrode, or back to the service grounding electrode if no approved electrodes are readily available. Size the grounding electrode conductor and bonding jumpers as indicated on the Drawings or as required by NFPA 70, whichever is larger.
- 5. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

C. CONNECTIONS

- 1. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals

in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.

- a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to 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.
2. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Replace welds that are puffed up or that show convex surfaces indicating improper cleaning. Use exothermic welded connections for the following:
 - a. Connecting conductors together.
 - b. Connecting conductors to building steel.
 - c. Connecting conductors to plates.
 3. Compression Fittings: Permanent compression-type fittings may be used for the following rather than exothermic connections:
 - a. Connecting conductors together.
 - b. Connecting conductors to building steel.
 4. Mechanical Pressure Fittings: Use bolted mechanical (removable) pressure-type clamps for the following:
 - a. Connecting conductors to pipes.
 5. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
 6. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
 7. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
 8. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.03 IDENTIFICATION

- A. Provide identification as specified in Division 26 "Low-Voltage Electrical Power Conductors and Cables" and "Identification for Electrical Systems"

3.04 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 2. Test Values:

- a. Equipment Rated 500 kVA and Less: 10 ohms.
 - b. Equipment Rated 500 to 1000 kVA: 5 ohms.
 - c. Equipment Rated More Than 1000 kVA: 3 ohms.
3. Perform point-to-point megohmmeter tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
4. Minimum system neutral-to-ground insulation resistance: one megohm.
5. Investigate point-to-point resistance values that exceed 0.5 ohms.
 - a. Check for loose connections.
 - b. Check for absent or broken connections.
 - c. Check for poor quality welds.
 - d. Consider other reasons.

END OF SECTION 26 05 26