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**Judith Enyeart Reynolds Complex
75% Construction Documents**

PROJECT NUMBER: 230601-136

August 9, 2024

SECTION 00 00 00 - TABLE OF CONTENTS

VOLUME 1

DIVISION 00	PROCUREMENT AND CONTRACT REQUIREMENTS	PAGES
00 00 00	TABLE OF CONTENTS	7
00 01 03	PROJECT DIRECTORY	1
00 01 07	SEAL PAGE	1
00 31 19	EXISTING CONDITION INFORMATION	1
00 31 32	GEOTECHNICAL DATA	1
	GEOTECHNICAL REPORT	47
00 70 00	GENERAL CONDITIONS OF THE CONTRACT	36
00 80 00	SUPPLEMENTARY GENERAL CONDITIONS	3
00 91 13	ADDEDNDA	1
	MISSOURI DIVISION OF LABOR STANDARDS - WAGE REPORT	
CM MANUAL		
	00 21 13 INSTRUCTIONS TO BIDDERS	
	00 30 00 SITE ACCESS PLAN	
	00 31 13 MILESTONE SCHEDULE OF CONSTRUCTION	
	00 41 00.10 INDIVIDUAL SCOPE(S) BID FORM	
	00 41 00.20 COMBINATION BID FORM	
	00 41 00.A BID FORM ATTACHMENT A - BEST VALUE TRADE PARTNER SELECTION	
	00 41 00.B BID FORM ATTACHMENT B - GOAL PARTICIPATION TABULATION	
	00 41 00.C BID PROPOSAL COST BREAKDOWN	
	00 52 00.10 CONTRACT BETWEEN CONTRACTOR AND SUBCONTRACTOR	
	00 52 00.11 CONTRACT BETWEEN CONTRACTOR AND SUBCONTRACTOR -Exhibit B1	
	00 52 00.20 MATERIAL AND EQUIPMENT (M&E) CONTRACT	
	00 52 00.30 MATERIAL AND EQUIPMENT PURCHASE ORDER (MPO)	
	00 61 13 PERFORMANCE AND PAYMENT BOND	
	00 62 76.10 PAY APPLICATION FORM	
	00 62 76.20 PARTIAL WAIVER AND AFFIDAVIT (PRE-PAYMENT): SUBCONTRACTOR AND SUPPLIER	
	00 62 76.30 PARTIAL WAIVER AND AFFIDAVIT (POST-PAYMENT): SUBCONTRACTOR AND SUPPLIER	
	00 62 79.10 STORED MATERIALS FORMS: BILL OF SALE	
	00 62 79.20 STORED MATERIALS FORMS: NON-NEGOTIABLE BAILMENT	
	00 65 00.10 FINAL WAIVER AND AFFIDAVIT (PRE-PAYMENT): SUBCONTRACTOR AND SUPPLIER	
	00 65 00.20 FINAL WAIVER AND AFFIDAVIT (POST-PAYMENT): SUBCONTRACTOR AND SUPPLIER	
	00 72 00 Prime Contract between Owner and Contractor	
	00 73 00 SPECIFIC PROJECT REQUIREMENTS	
	00 73 00.A ATTACHMENT A - ELECTRONIC DATA RELEASE	
	00 73 00.B ATTACHMENT B - FEDERAL COORDINATION PROGRAM (BIM)	
	00 73 00.B ATTACHMENT B - COORDINATION PROGRAM (BIM)	
	00 73 00.C ATTACHMENT C - SPECIAL PROJECT REQUIREMENTS FOR EXISTING FACILITIES	
	00 73 10 SPECIFIC PROJECT REQUIREMENTS: TEMPORARY FACILITIES AND CONTROLS	

00 73 16 INSURANCE PROGRAM – DCIP (GL only)
00 73 19 SAFETY REQUIREMENTS
00 73 36 EQUAL OPPORTUNITY
00 73 43 PREVAILING WAGE REQUIREMENTS
00 99 00 REVISIONS TO FRONT END DOCUMENTS

DIVISION 01 GENERAL REQUIREMENTS

01 10 00	SUMMARY	6
01 21 00	ALLOWANCES	3
01 22 00	UNIT PRICES	2
01 23 00	ALTERNATES	2
01 25 00	SUBSTITUTION PROCEDURES	3
01 26 00	CONTRACT MODIFICATION PROCEDURES	3
01 29 00	PAYMENT PROCEDURES	5
01 31 00	PROJECT MANAGEMENT AND COORDINATION	9
01 32 00	CONSTRUCTION PROGRESS DOCUMENTATION	6
01 32 33	PHOTOGRAPHIC DOCUMENTATION	3
01 33 00	SUBMITTAL PROCEDURES	6
01 40 00	QUALITY REQUIREMENTS	7
01 42 00	REFERENCES	2
01 43 39	MOCKUPS	5
01 50 00	TEMPORARY FACILITIES AND CONTROLS	7
01 60 00	PRODUCT REQUIREMENTS	5
01 65 00	REQUEST FOR SUBSTITUTION DURING BIDDING	2
01 73 00	EXECUTION	5
01 74 00	WARRANTIES	2
01 74 19	CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL	8
01 77 00	CLOSEOUT PROCEDURES	6
01 78 23	OPERATION AND MAINTENANCE DATA	6
01 78 39	PROJECT RECORD DOCUMENTS	3
01 79 00	MINIMUM OWNER TRAINING REQUIREMENTS	8
01 91 13	GENERAL COMMISSIONING REQUIREMENTS	16

DIVISION 02 EXISTING CONDITIONS

02 41 00	SITE DEMOLITION	3
02 41 19	DEMOLITION	7

DIVISION 03 CONCRETE

03 20 00	CONCRETE REINFORCING	4
03 30 00	CAST IN PLACE CONCRETE	12
03 35 43	POLISHED CONCRETE	7

DIVISION 04 MASONRY (NONE)

04 20 00	UNIT MASONRY	7
04 22 23	ARCHITECTURAL CONCRETE UNIT MASONRY	5
04 43 13	STONE MASONRY VENEER	7

DIVISION 05 METALS

05 12 00	STRUCTURAL STEEL FRAMING	9
05 21 00	STEEL JOIST FRAMING	3
05 31 00	STEEL DECKING	5
05 40 00	COLD FORMED METAL FRAMING	8
05 50 00	METAL FABRICATIONS	9
05 51 00	METAL STAIRS	5
05 70 00	DEORATIVE METAL	7
05 73 11	DECORATIVE METAL AND GLAZED RAILINGS	13
DIVISION 06	WOOD, PLASTICS, AND COMPOSITES	
06 10 00	ROUGH CARPENTRY	7
06 16 00	GYP SHEATHING	3
06 40 23	INTERIOR ARCHITECTUAL WOODWORKING	12
DIVISION 07	THERMAL AND MOISTURE PROTECTION	
07 11 13	BITUMINOUS DAMPPROOFING	4
07 14 00	FLUID-APPLIED WATERPROOFING	6
07 21 00	THERMAL INSULATION	4
07 27 26	FLUID-APPLIED MEMBRANE AIR BARRIERS	7
	BASIS OF DESIGN FLUID-APPLIED MEMBRANE AIR BARRIERS DETAILS	X
07 42 13	METAL WALL & SOFFIT PANELS	5
07 42 13.23	METAL COMPOSITE MATERIAL WALL PANEL SYSTEM	8
07 42 30	WOOD RAINSCREEN SYSTEM	6
07 42 43	EXTERIOR HIGH PRESSURE LAMINATED COMPOSITE PANELS	4
07 54 00	THERMOPLASTIC POLYOLEFIN (TPO) ROOFING	8
	NRCA DETAILS	X
07 62 00	SHEET METAL FLASHING AND TRIM	9
07 72 00	ROOF ACCESSORIES	7
07 82 05	BOARD AND BLANK FIREPROOFING	X
07 84 00	FIRESTOPPING	X
07 92 00	JOINT SEALANTS	7
07 95 13	EXPANSION CONTROL COVER ASSEMBLIES	X
DIVISION 08	OPENINGS	
08 11 13	HOLLOW METAL DOORS AND FRAMES	9
08 14 16	FLUSH WOOD DOORS	6
08 31 00	ACCESS DOORS AND FRAMES	3
08 34 73	SOUND CONTROL DOOR AND WINDOW ASSEMBLIES	9
08 43 13	ALUMINUM-FRAMED ENTRANCES	10
08 44 13	GLAZED ALUMINUM CURTAIN WALLS	11
08 44 35	FIRE RATED GLAZED ASSEMBLIES	7
08 64 00	METAL-FRAMED GLASS FLOOR SYSTEM	5
08 71 00	DOOR HARDWARE	7
08 71 01	DOOR HARDWARE SCHEDULE	49
08 80 00	GLAZING	11
08 83 00	MIRRORS	3
DIVISION 09	FINISHES	

09 21 16	GYPSUM BOARD ASSEMBLIES	8
09 22 16	NON-STRUCTURAL METAL FRAMING	6
09 30 00	TILING	7
09 51 00	ACOUSTICAL TILE CELINGS	9
09 58 13	MONOLITIC ACOUSTICAL CEILING SYSTEM	7
09 64 70	WOOD DANCE FLOORING	3
09 65 00	RESILIENT FLOORING	4
09 66 23	RESINOUS MATRIX TERRAZZO FLOORING	8
09 68 13	TILE CARPETING	5
09 72 16	FELT WALLCOVERING	4
09 73 00	ACOUSTICAL WOOD WALL PANELS	3
09 84 30	SOUND-ABSORBING WALL AND CEILING UNITS	X
09 84 36.16	CEMENTITIOUS WOOD-FIBER PANELS (TECTUM)	4
09 90 00	PAINTS, HIGH PERFORMANCE PAINTS, STAINS, AND COATINGS	10
09 96 72	FLUID APPLIEC INSULATION COATING	8

DIVISION 10 SPECIALTIES

10 14 00	SIGNAGE	4
10 14 16	PLAQUES	3
10 14 19	DIMENSIONAL LETTER SIGNAGE	4
10 21 13.17	PHENOLIC-CORE TOILET COMPARTMENTS	2
10 28 00	TOILET, BATH AND LAUNDRY ACCESSORIES	X
10 44 00	FIRE-PROTECTION SPECIALTIES	4

DIVISION 11 EQUIPMENT

11 05 00	COMMON REQUIREMENT FOR EQUIPMENT	3
11 60 00	THEATER EQUIPMENT	9
11 60 01	THEATER AND STAGE EQUIPMENT	7

DIVISION 12 FURNISHINGS

12 24 13	ROLLER WINDOW SHADES	8
12 93 12	BICYCLE RACKS	X
12 93 23	TRASH RECEPTACLES	X

DIVISION 13 SPECIAL CONSTRUCTION (NONE)

DIVISION 14 CONVEYING EQUIPMENT

14 24 00	HYDRALIC ELEVATOR	11
	ELEVATOR REPORT	14

VOLUME 2

DIVISION 20 BASIC MECHANICAL CONTROL

20 00 00	BASIC MECHANICAL CONDITIONS	2
20 05 48	SEISMIC CONTROLS	9
20 05 49	VIBRATION CONTROLS	9
20 10 00	BASIC MECHANICAL MATERIALS AND METHODS	5
20 10 10	BASIC PIPING MATERIALS	15
20 10 20	VALVES AND STRAINERS	14
20 10 30	HANGERS, SHIELDS, SUPPORTS AND ANCHORS	6
20 10 40	SLEEVES AND SEALS	5
20 10 50	BASIC MECHANICAL METHODS - RELATED WORK	4
20 10 60	TESTING, ADJUSTING AND BALANCING	12
20 10 70	IDENTIFICATION	8
20 20 10	ELECTRICAL REQUIREMENTS	5
20 20 20	DRIVES AND GUARDS	3
20 20 25	INSULATION	23
DIVISION 21	FIRE SUPPRESSION	
21 00 00	FIRE PROTECTION SYSTEM	2
21 00 10	FIRE PROTECTION DESIGN	5
21 00 20	PIPING AND ACCESSORIES	9
21 00 30	WET PIPE SPRINKLER SYSTEM	5
21 00 40	DRY-PIPE SPRINKLER SYSTEM	12
21 00 70	STANDPIPE AND HOSE SYSTEMS	3
DIVISION 22	PLUMBING	
22 00 00	PLUMBING WORK	3
22 08 00	COMMISSIONING OF PLUMBING SYSTEMS	x
22 10 00	PLUMBING PIPING SYSTEMS	9
22 30 00	DRAINS AND CLEANOUTS	8
22 40 00	PLUMBING FIXTURES	23
22 50 00	PLUMBING EQUIPMENT	10
22 80 00	PLUMBING SPECIALTIES	13
DIVISION 23	HEATING, VENTILATING, AND AIR CONDITIONING	
23 00 00	HVAC PIPING AND EQUIPMENT	3
23 08 00	COMMISSIONING OF HVAC SYSTEMS	x
23 21 00	HYDRONIC PIPING AND EQUIPMENT	13
23 21 20	HYDRONIC PUMPS AND ACCESSORIES	6
23 22 00	STEAM AND CONDENSATE PIPING AND EQUIPMENT	10
23 23 00	REFRIGERANT PIPING	2
23 25 00	HVAC WATER TREATMENT	10
23 51 00	BREECHING, CHIMNEYS, AND STACKS	5
23 57 00	HEAT EXCHANGERS	4
23 73 00	CENTRAL STATION AIR HANDLING UNITS	18
23 74 00	PACKAGED OUTDOOR HVAC EQUIPMENT	11
23 81 00	UNITARY HVAC EQUIPMENT	7
23 82 00	CONVECTION HEATING AND COOLING UNITS	13
23 83 00	RADIANT HEATING AND COOLING UNITS	2
DIVISION 24	AIR DISTRIBUTION	

24 00 00	AIR DISTRIBUTION	2
24 31 00	SHEETMETAL DUCTWORK	13
24 30 00	DUCTWORK ACCESSORIES	14
24 33 50	INTERNAL ACOUSTICAL DUCT LINING	4
24 34 00	FANS	5
24 35 00	DUST COLLECTION SYSTEM	3
24 37 00	AIR DEVICES	8
24 41 00	FILTER ASSEMBLIES	5
DIVISION 25	TEMPERATURE CONTROL	
25 00 00	TEMPERATURE CONTROL SYSTEM	7
25 10 00	CONTROL SYSTEM REQUIREMENTS	20
25 20 00	AIR SIDE CONTROL EQUIPMENT	14
25 30 00	HYDRONIC CONTROL EQUIPMENT	11
25 40 00	AUXILLARY EQUIPMENT	8
25 50 00	WIRING MATERIALS AND METHODS	4
DIVISION 26	ELECTRICAL	
26 08 00	COMMISSIONING OF ELECTRICAL SYSTEMS	x
26 05 13	MEDIUM VOLTAGE CABLE, TERMINATIONS, AND SPLICES	4
26 05 19	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES	6
26 05 26	Grounding and Bonding for Electrical Systems	8
26 05 33	RACEWAY FOR ELECTRICAL SYSTEMS	7
26 05 34	BOXES FOR ELECTRICAL SYSTEMS	4
26 05 36	CABLE TRAYS FOR ELECTRICAL SYSTEMS	3
26 05 48	SEISMIC RESTRAINT	2
26 05 73	ARC FLASH HAZARD ANALYSIS, SHORT CIRCUIT ANALYSIS, AND SELECTIVE	5
26 08 00	COMMISSIONING OF BUILDING SYSTEMS	1
26 09 13	ELECTRICAL POWER METERING	4
26 09 23	LIGHTING CONTROL DEVICES	4
26 09 43	NETWORK ADDRESSABLE LIGHTING CONTROLS	4
26 09 61	THEATRICAL LIGHTING CONTROLS	2
26 12 19	MEDIUM VOLTAGE PAD-MOUNTED LIQUID-FILLED TRANSFORMERS	3
26 13 00	MEDIUM-VOLTAGE SWITCHGEAR	2
26 22 13	LOW-VOLTAGE DRY-TYPE TRANSFORMERS	3
26 24 13	SWITCHBOARDS	2
26 24 16	PANELBOARDS	4
26 27 13	METERING	2
26 27 26	WIRING DEVICES	10
26 28 13	FUSES	2
26 28 16	DISCONNECT SWITCHES	2
26 28 19	ELEVATOR POWER MODULE SWITCH	2
26 29 13	MOTOR AND APPLIANCE CONTROL	3
26 29 23	VARIABLE FREQUENCY DRIVES	5
26 41 13	LIGHTNING PROTECTION	2
26 43 13	SURGE PROTECTIVE DEVICES (SPD)	2
26 51 00	LED LIGHTING	7
26 52 13	EMERGENCY LIGHTING TRANSFER DEVICES	2

DIVISION 27 COMMUNICATIONS

27 05 28	PATHWAYS FOR COMMUNICATIONS SYSTEMS	3
27 13 13	COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING	4
27 15 13	COMMUNICATIONS COPPER HORIZONTAL CABLING SYSTEMS	4
27 15 33	COMMUNICATIONS COAXIAL HORIZONTAL CABLING SYSTEMS	2
27 41 00	AUDIO-VIDEO SYSTEMS	9
27 53 13	CLOCK AND TIME TONE SYSTEM	6

DIVISION 28 ELECTRONIC SAFETY AND SECURITY

28 05 28	PATHWAYS FOR ELECTRONIC AND SAFETY SYSTEMS	3
28 23 00	VIDEO SURVEILLANCE SYSTEMS	7
28 30 00	FIRE DETECTION AND ALARM SYSTEM	8

DIVISION 31 EARTHWORK

31 10 00	SITE CLEARING	2
31 22 13	ROUGH GRADING	2
31 23 16	EXCAVATION	4
31 23 23	FILL	5
31 25 00	EROSION AND SEDIMENTATION CONTROL	2

DIVISION 32 EXTERIOR IMPROVEMENTS

32 11 22	AGGREGATE BASE COURSES	2
32 13 13	CONCRETE PAVING	12
32 13 73	CONCRETE PAVING JOINT SEALANTS	4
32 14 43	POROUS UNIT PAVING	10
32 31 19	DECORATIVE METAL FENCES AND GATES	4
32 84 00	PLANTING IRRIGATION	9
32 91 13	SOIL PREPARATION	13
32 92 00	TURF AND GRASSES	8
32 93 00	EXTERIOR PLANTS	25

DIVISION 33 UTILITIES

33 05 13	SEWER MANHOLES, FRAMES AND COVERS	3
33 10 00	WATER UTILITIES	7
33 31 11	SANITARY SEWER SYSTEMS	4
33 40 00	STORM DRAINAGE UTILITIES	3
33 49 00	STORM DRAINAGE STRUCTURES	3

DIVISION 34 TRANSPORTATION

34 41 16	TRAFFIC CONTROL EQUIPMENT	2
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END OF TABLE OF CONTENTS

SECTION 00 01 00 - PROJECT DIRECTORY

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Contact: Leslie Tabor

END OF SECTION 00 01 00

SECTION 00 01 07 - SEALS PAGE

I hereby certify that these Drawings and/or Specifications have been prepared by me, or under my supervision. I further certify that to the best of my knowledge these Drawings and/or Specifications are as required by and in compliance with Building Codes of the City of Springfield, Missouri.

DISCLAIMER OF RESPONSIBILITY

I hereby specify, that the documents indented to be authenticated by my seal are limited to:

Specifications: (sections)

Drawings: (sheets)

PROFESSIONAL SEAL

SEALS PAGE

DOCUMENT 00 31 19 - EXISTING CONDITION INFORMATION

1.1 RELATED DOCUMENTS

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

1.2 EXISTING CONDITION INFORMATION

- A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of the Bidders' own investigations. They are made available for Bidders' convenience and information, but are not a warranty of existing conditions. This Document and its attachments are not part of the Contract Documents.
- B. Existing drawings from (year) that include information on existing conditions can be obtained through the Architect.
- C. Survey information that includes information on existing conditions, prepared by CMT Engineering, is available for viewing as part of Drawings - see sheet C1.0 – Survey Plan.
- D. Related Requirements:
 - 1. Document 2.00 "Bidding Instructions and Supplemental Information" in the Construction Manager's Manual for the Bidder's responsibilities for examination of Project site and existing conditions.
 - 2. Document 00 31 32 "Geotechnical Data" for reports and soil-boring data from geotechnical investigations that are made available to bidders.

END OF DOCUMENT 00 31 19

DOCUMENT 00 31 32 - GEOTECHNICAL DATA

1.1 GEOTECHNICAL DATA

- A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information. This Document and its attachments are not part of the Contract Documents.
- B. Because subsurface conditions indicated by the soil borings are a sampling in relation to the entire construction area, and for other reasons, the Owner, the Architect, the Architect's consultants, and the firm reporting the subsurface conditions do not warranty the conditions below the depths of the borings or that the strata logged from the borings are necessarily typical of the entire site. Any party using the information described in the soil borings and geotechnical report shall accept full responsibility for its use.
- C. Soil-boring data for Project, obtained by Terracon Consultants, Inc., dated November 14, 2023, is available for viewing as appended to this Document.
- D. A geotechnical investigation report for Project, prepared by Terracon Consultants, Inc., dated November 14, 2023 is available for viewing as appended to this Document.
 - 1. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from the data.
 - 2. Any party using information described in the geotechnical report shall make additional test borings and conduct other exploratory operations that may be required to determine the character of subsurface materials that may be encountered.
- E. Related Requirements:
 - 1. Document 00 31 19 "Existing Condition Information" for information about existing conditions that is made available to bidders.

END OF DOCUMENT 00 31 32

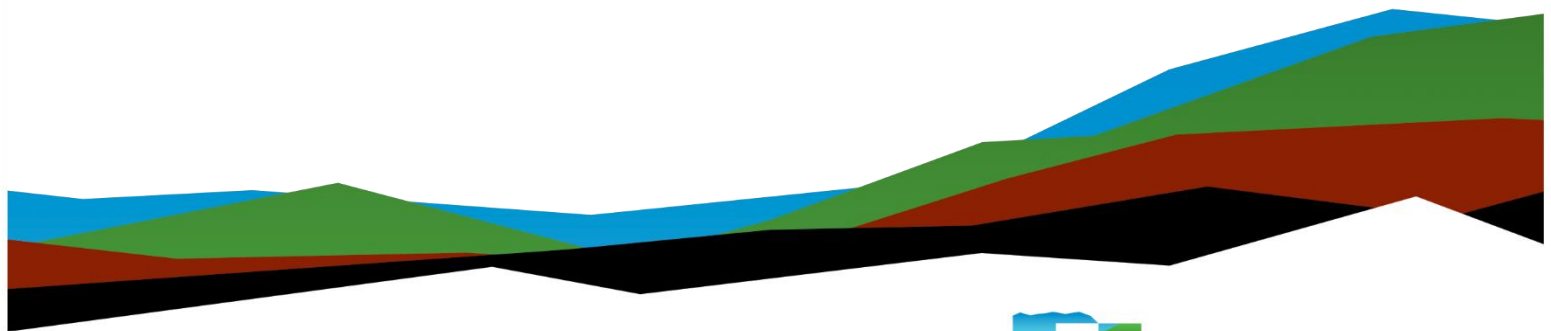
Art Annex Building

Geotechnical Engineering Report

November 14, 2023 | Terracon Project No. B5235061

Prepared for:

Missouri State University
Springfield, MO 65897



Nationwide
Terracon.com

- Facilities
- Environmental
- Geotechnical
- Materials



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November 14, 2023

Missouri State University
901 S National Ave
Springfield, MO 65897

Attn: Mr. Mark Wheeler
P: (417) 836-5101
E: markwheeler@missouristate.edu

Re: Geotechnical Engineering Report
Art Annex Building
1045 Grand Street
Springfield, Missouri
Terracon Project No. B5235061

Dear Mr. Wheeler:

We have completed a subsurface exploration and geotechnical engineering evaluation for the referenced project in general accordance with Terracon Proposal No. PB5235061 dated September 29, 2023. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon

Ripken B. Dodson, E.I.
Staff Geotechnical Engineer

Jamie Klein, P.E.
Senior Associate

Table of Contents

Introduction..... 1

Project Description..... 1

Site Conditions 2

Geotechnical Characterization 3

Geologic Hazards..... 4

Seismic Site Class..... 4

Geotechnical Overview 4

 Existing Fill 4

 Swell Potential 5

 General..... 6

Earthwork 6

 Demolition 6

 Site Preparation..... 6

 Excavation..... 7

 Subgrade Stabilization 8

 Fill Material Types 8

 Fill Placement and Compaction Requirements 9

 Utility Trench Backfill 10

 Grading and Drainage..... 11

 Earthwork Construction Considerations 11

 Construction Observation and Testing 12

 Construction Adjacent to Existing Building 13

Ground Improvement 13

Deep Foundations..... 13

 Drilled Shaft Design Parameters 14

 Drilled Shaft Lateral Resistance 15

 Drilled Shaft Construction Considerations 16

Floor Slabs 17

 Floor Slab Design Parameters 18

 Floor Slab Construction Considerations..... 19

General Comments 19

 Unconfined Compressive Strength of Rock Results 3

Figures

GeoModel

Attachments


Exploration and Testing Procedures

Rock Core Photography Log

Site Location and Exploration Plans

Exploration and Laboratory Results

Supporting Information

Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the  logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

Refer to each individual Attachment for a listing of contents.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed new Art Annex Building to be located at 1045 Grand Street on the Missouri State University campus in Springfield, Missouri. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil (and rock) conditions
- Groundwater conditions
- IBC seismic site class
- Site preparation and earthwork
- Demolition considerations
- Foundations
- Floor slabs

Drawings showing the site and boring locations are shown on the attached [Site Location Plan](#) and [Exploration Plan](#). The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs and/or as separate graphs in [Exploration Results](#).

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	Information was provided by Ms. Emily McGee with MSU.
Project Description	The project consists of demolition of the existing Art Annex Building and construction of a new two-story building with a similar footprint.
Proposed Structure	Based on our understanding of the existing building, we anticipate the new building will consist of precast concrete construction and will be supported on drilled shaft foundations.

Item	Description
Finished Floor Elevation	Not provided; however, the first-floor elevation for the proposed building is anticipated to be at or near the existing building's floor level.
Maximum Loads	<p>Anticipated structural loads were not provided. We have assumed the following maximum loads based on our experience with similar projects.</p> <ul style="list-style-type: none"> ■ Columns: 300 kips ■ Walls: 12 kips per linear foot (klf) ■ Slabs: 150 pounds per square foot (psf)
Grading	A site grading plan was not provided. We have considered no more than 3 feet of cut and/or fill will be required to develop final grades.
Below-Grade Structures	No below grade or basement levels are planned.
Free-Standing Retaining Walls	No free-standing retaining walls are planned.

Terracon should be notified if any of the above information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	<p>The project is located at 1045 Grand Street on the MSU campus in Springfield, Missouri.</p> <p>Approximate Latitude/Longitude: 37.1972, -93.2788</p> <p>See Site Location</p>
Existing Improvements	Existing Art Annex building with associated landscaping and planter walls and sidewalks along with adjacent Karls Hall building to the north and Grand Street to the south.
Current Ground Cover	Sidewalks and landscaping on the south side of the existing building, asphalt/concrete pavement to the north and east of the existing building

Item	Description
Existing Topography	Based on Google Earth, the site is slightly sloped away from the existing building.

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based on the subsurface exploration, laboratory data, geologic setting, and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical evaluation. Conditions observed at each boring location are indicated on the individual logs. The individual logs are in the [Exploration Results](#) and the GeoModel is in the [Figures](#) attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	Fill Material	Brown lean clay fill material with varying amounts of gravel
2	Lean Clay	Brown and red brown lean clay with varying amounts of gravel. Possible fill material
3	Fat Clay	Red brown fat clay with varying amounts of gravel and sand
4	Limestone	Limestone bedrock with varying degrees of weathering

The borings were observed during drilling for the presence and level of water. Groundwater was not encountered in the borings at these times. A longer period of time may be required for groundwater to develop and stabilize in a borehole. Longer term observations in piezometers or observation wells, sealed from the influence of surface water, are often required to define groundwater levels.

Groundwater levels may fluctuate due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the borings were performed. "Perched" water could occur above lower permeability soil layers and/or near the soil/bedrock interface, and "trapped" water could be present within existing fill materials. Therefore, groundwater conditions at other times may be different than the conditions encountered in our exploratory borings. The potential for water level fluctuations and perched water should be considered when developing design and construction plans and specifications for the project.

Geologic Hazards

Karst features are mapped in the area and a potential karst feature was observed just south of the building during the Grand Street Underpass construction. It is difficult to predict future sinkhole activity. Site grading and drainage may alter site conditions and could possibly cause sinkholes in areas that have no history of this activity.

Seismic Site Class

The seismic design requirements for buildings and other structures are based on Seismic Design Category. The Site Class is required to determine the Seismic Design Category for a structure. The Site Class is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil and bedrock encountered in our subsurface exploration, **Seismic Site Class D** can be considered for design of the project. The subsurface exploration at this site extended to a maximum depth of 37 feet. The site properties below the maximum boring depth were estimated based on our experience and knowledge of geologic conditions of the general area. Upon request, we could perform deeper borings or geophysical testing to confirm the conditions below the current maximum boring depth.

Geotechnical Overview

Based on conditions encountered at the boring locations, it appears feasible to support the new building on drilled shaft foundations that bear in the underlying bedrock; however, remediation of the existing fill for floor slab support will be required as described below. Based on the provided structural loads and history of karst conditions in the immediate vicinity, support of the building on shallow footing foundations does not appear feasible. As an alternative to deep foundations, support of the building on a ground improvement system (such as stone columns or aggregate piers) could be considered; however, a specialty design-build contractor should be consulted to determine if a ground improvement system is feasible for this project. Ground improvement systems are designed and constructed on a design-build basis by specialty contractors.

Existing Fill

Existing fill and possible fill materials were found to depths ranging from about 10 to 12 feet in the borings. The fill and possible fill generally consisted of lean clay with varying

amounts of gravel and exhibited variable moisture content and consistency. Fill should be expected (possibly to a greater depth) in other areas across the site. We are not aware whether the existing fill has been placed with moisture and density controls. Floor slabs supported on or above existing uncontrolled fill material that has not been uniformly placed and compacted with strict moisture and density controls may not perform predictably. We do not recommend supporting the new floor slabs on the existing fill without remediation.

If the owner is willing to accept risks associated with post-construction differential settlement of slabs, then consideration could be given to leave portions of the existing fill material. We recommend the existing fill be removed a minimum of 3 feet below the planned FFE and 5 feet beyond the building footprint. At that depth, any existing fill remaining should be evaluated by Terracon. The upper 2 feet of backfill should consist of LVC material placed as recommended herein.

The depth and composition of the existing fill materials can vary greatly over relatively small lateral and vertical distances. Because of this variability, it may not be possible (until site grading is underway) to accurately predict the amount of fill that will need to be removed and replaced to develop suitable support for the proposed improvements. Caution should be exercised when using the depth and composition of the fill observed at the discrete boring locations for estimating purposes.

Swell Potential

Expansive fat clay soils were encountered at the site. These materials have the potential to shrink and swell with seasonal fluctuations in the soil moisture content. We recommend the floor slabs be supported on at least 24 inches of low volume change (LVC) material. In areas that are currently above or less than 2 feet below the planned bottom of floor slab level, native fat clay soils should be undercut to accommodate placement of LVC material. In areas where more than 2 feet of fill will be placed below the bottom-of-floor-slab level, at least the upper 24 inches of new engineered fill should consist of LVC material. Placement of a layer of LVC material below floor slabs, as recommended in this report, will not eliminate all future subgrade volume change and resultant floor slab movements. However, use of an LVC zone should reduce the potential for subgrade volume change. Details regarding the LVC zone are provided in [Earthwork](#).

This report provides recommendations to help mitigate the effects of soil shrinkage and expansion. However, even if these procedures are followed, some movement and at least minor cracking in the structure could still occur. The severity of cracking and other cosmetic damage caused by movement of the floor slabs will probably increase if any modification of the site results in excessive wetting or drying of the expansive soils. Eliminating the risk of movement and cosmetic distress may not be feasible, but it may be possible to further reduce the risk of movement if significantly more expensive

measures are used during construction. We would be pleased to discuss other construction alternatives with you upon request.

General

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the [Exploration Results](#)), engineering analyses, and our current understanding of the proposed project. The [General Comments](#) section provides an understanding of the report limitations.

Earthwork

Site preparation, excavation, subgrade preparation, and placement of engineered fill should follow the recommendations presented in this section. The recommendations presented for design and construction of earth-supported elements, including foundations and slabs, are contingent upon the recommendations outlined in this section being followed. We recommend earthwork on this project be observed and evaluated by Terracon. The evaluation of earthwork should include observation and testing of subgrade preparation, engineered fill, foundation bearing soils, and other geotechnical conditions exposed during the construction of the project.

Demolition

Demolition of the existing structure should include removal of all above-grade and below-grade elements including floor slabs, foundation walls, and footings. Attention should be given to removing all loose or poorly compacted existing fill materials that are often located adjacent to existing and former foundation walls. All existing utilities should also be properly abandoned and/or relocated. This should include removal of all poorly compacted trench backfill extending into the proposed structure area. In addition, care should be taken by contractors to protect all existing improvements to remain, such as sidewalks, pavements, and utilities. Excavations created by demolition and removal of existing features should be backfilled with engineered fill that is placed and compacted as recommended in this report.

Site Preparation

Vegetation, topsoil, and any loose, soft, or otherwise unsuitable soils present within the proposed construction areas should be stripped. Based on information obtained at the boring locations, stripping depths on the order of 6 inches should be anticipated to remove the root zone materials. However, greater stripping depths may be required in areas not explored by

the borings. Organic soils removed during site preparation should not be used as fill beneath the proposed new building and pavement areas.

As noted in [Geotechnical Characterization](#), the borings encountered existing fill and possible fill to depths of up to about 8 and 10 feet below existing grades. Support of floor slabs on or above existing fill soils without remediation is not recommended. There is inherent risk for the owner that compressible fill or unsuitable material, within or buried by the fill will, not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill. However, if the owner is willing to accept the risks to construct the building and pavements on the existing fill, the recommendations described in [Geotechnical Overview](#) should be followed.

Where existing fill materials are present following initial site stripping and initial cuts, the existing fill should then be further evaluated by a representative of Terracon by exploring using hand equipment or test pits, field density tests and/or possibly obtaining additional samples for further laboratory testing. If unsuitable materials are encountered at this time, these materials should be removed and replaced with controlled engineered fill.

The soils within the planned building area should be further undercut as necessary to accommodate placement of the recommended 24-inch thick LVC layer below floor slabs. The undercut areas should extend a minimum of 5 feet laterally outside the building wall lines. Undercutting to facilitate placement of the LVC layer would not be necessary in areas where more than 2 feet of fill will be placed to develop the floor slab subgrade level.

Following initial stripping and any necessary undercutting, the exposed soils should be proofrolled. A Terracon representative should observe the proofrolling. Proofrolling can be accomplished using a loaded tandem-axle dump truck with a gross weight of at least 20 tons, or similarly loaded equipment. Areas that display excessive deflection (pumping) or rutting during proofroll operations should be improved by scarification/compaction or by removal and replacement with engineered fill.

Excavation

We anticipate that shallow excavations for the proposed construction can be accomplished with conventional earthmoving equipment. The bottom of excavations should be thoroughly cleaned of loose soils and disturbed materials prior to backfill placement and/or construction.

Due to presence of weathered limestone, drilled shaft excavation will encounter very hard materials. A drilled-shaft rig equipped with hard formation drilling bits (rock drill type bit) and/or a core barrel having high torque capacity may be required for installation of piers to achieve appropriate pier depths.

Subgrade Stabilization

Due to the presence of soils with high moisture content and relatively low strength, some means of subgrade stabilization may be required to facilitate construction, especially if wet soils are encountered during site preparation or if the subgrade becomes saturated by precipitation during site preparation/earthwork operations.

In general (weather permitting), scarifying, drying, and compacting the exposed subgrades is expected to be the most economical means of improving these soils prior to placing new fill. However, this option is typically less effective where soft/wet soils are more than about one foot thick. Alternatives for subgrade stabilization could include undercutting unsuitable (wet, low strength, and/or disturbed) soils followed by the addition of crushed stone aggregate (typically on the order of 12 to 18 inches thick) to improve subgrade stability, or the incorporation of a chemical additive such as Portland cement or Class C fly ash. The need for stabilization, and the most appropriate type of stabilization, will be dependent upon soil, groundwater, and weather conditions at the time of construction. The proposed grading plan, the construction schedule, and construction methods will also affect the selection of stabilization method. Terracon should be retained during construction to help provide recommendations as needed.

Fill Material Types

Fill required to achieve design grade should be classified as structural fill and general fill. Structural fill (also referred to as engineered fill) is material used below, or within 10 feet of structures, pavements, or constructed slopes. General fill is material used to achieve grade outside of these areas.

Reuse of On-Site Soil: Excavated on-site soil may be selectively reused as fill below pavement and landscaping areas.

Material property requirements for on-site soil for use as general fill and engineered fill are noted in the table below:

Fill Type	USCS Classification	Acceptable Location for Placement
Native Fat Clays and/or Lean to Fat Clays (LL \geq 45 and/or PI \geq 23)	CH, CL/CH	Pavement areas and at depths greater than 24 inches below building finished grade

Fill Type	USCS Classification	Acceptable Location for Placement
Existing Fill	CL	All locations and elevations, except where free-draining material is required provided material is observed, tested, and approved by Terracon. Organics, rock/rubble fragments larger than 3 inches, debris, or other unsuitable materials should be removed prior to re-use of the existing fill in engineered fill sections.
Native Lean Clays (LL<45 and PI<23)	CL	All locations and elevations, except where free-draining material is required

Imported Fill Materials: Imported fill materials should meet the following material property requirements. Regardless of its source, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.

Fill Type	USCS Classification	Acceptable Location for Placement
Low Volume Change (LVC) material	GM ² or CL (LL<45 and PI<23)	All locations and elevations, except where free-draining material is required
Free Draining Granular	GW, GP, SW, SP	Less than 5% passing No. 200 sieve

1. Engineered fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.
2. MoDOT Type 5 or an approved alternate gradation of crushed limestone aggregate.
3. Granular materials with less than 5 percent fines (material passing the #200 sieve), such as ASTM C33 Size No. 57 aggregate or an approved alternate gradation.

Fill Placement and Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Structural Fill	General Fill
Maximum Lift Thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e., a jumping jack or plate compactor) is used	Same as structural fill
Minimum Compaction Requirements ^{1,2,3}	95% of max. below and above foundations, below floor slabs, and below pavements	92% of max.
Water Content Range ¹	Low plasticity cohesive: -2% to +3% of optimum High plasticity cohesive: 0 to +4% of optimum Granular: -3% to +3% of optimum	As required to achieve min. compaction requirements

1. Maximum density and optimum water content as determined by the standard Proctor test (ASTM D 698).
2. High plasticity cohesive fill should not be compacted to more than 100% of standard Proctor maximum dry density.
3. If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D 4253 and D 4254). Materials not amenable to density testing should be placed and compacted to a stable condition observed by the Geotechnical Engineer or representative.

Utility Trench Backfill

Any soft or unsuitable materials encountered at the bottom of utility trench excavations should be removed and replaced with structural fill or bedding material in accordance with public works specifications for the utility to be supported. This recommendation is particularly applicable to utility work requiring grade control and/or in areas where subsequent grade raising could cause settlement in the subgrade supporting the utility. Trench excavation should not be conducted below a downward 1:1 projection from existing foundations without engineering review of shoring requirements and geotechnical observation during construction.

On-site materials are considered suitable for backfill of utility and pipe trenches from 1 foot above the top of the pipe to the final ground surface, provided the material is free of organic matter and deleterious substances.

Trench backfills should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Where trenches are placed beneath slabs or footings, the backfill should satisfy the requirements of engineered fill discussed in this report. Flooding or jetting for placement and compaction of backfill is not recommended.

Utility trenches are a common source of water infiltration and migration. Utility trenches that penetrate beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. Each trench should be provided with an effective trench plug that extends at least 5 feet from the face of the building exterior. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If clay is used to construct the trench plug, the clay should be placed and compacted in accordance with the water content and compaction recommendations for structural fill provided in this report.

Grading and Drainage

The site should be graded to provide effective drainage away from the building during and after construction, and these conditions should be maintained throughout the life of the structure. Accumulation of water adjacent to the structure could contribute to significant moisture increases in the subgrade soils and subsequent softening/settlement or expansion/heave, which could result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks.

After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Terracon should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation, proofrolling, placement and compaction of engineered fill, backfilling of excavations into completed subgrades, and just prior to construction of foundations, slabs, and pavements.

Care should be taken to avoid disturbance of prepared subgrades. Unstable subgrade conditions can develop during general construction operations, particularly if the soils

are wetted and/or subjected to repetitive construction traffic. If unstable subgrade conditions develop, stabilization measures will need to be employed. Construction traffic over the completed subgrade should be avoided to the extent practical. If the subgrade becomes frozen, desiccated, saturated, or disturbed, the affected materials should be removed or these materials should be scarified, moisture conditioned, and compacted prior to floor slab construction.

Based on conditions encountered in the borings, significant seepage is generally not expected in excavations for this project (e.g., for footing construction and utility installation). If seepage is encountered in excavations during construction, the contractor is responsible for designing, implementing, and maintaining appropriate dewatering methods to control seepage and facilitate construction. In our experience, dewatering of excavations in clay soils can typically be accomplished using sump pits and pumps.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, state, and federal safety regulations. The contractor should be aware that slope height, slope inclination, and excavation depth should in no instance exceed those specified by these safety regulations. Flatter slopes than those dictated by these regulations may be required depending upon the soil conditions encountered and other external factors. These regulations are strictly enforced and if they are not followed, the owner, contractor, and/or earthwork and utility subcontractor could be liable and subject to substantial penalties. Under no circumstances should the information provided in this report be interpreted to mean that Terracon is responsible for construction site safety or the contractor's activities. Construction site safety is the sole responsibility of the contractor who shall also be solely responsible for the means, methods, and sequencing of the construction operations.

Construction Observation and Testing

The earthwork efforts should be observed by the Geotechnical Engineer (or others under their direction). Observation should include documentation of adequate removal of surficial materials (vegetation, topsoil, and pavements), evaluation and remediation of existing fill materials, as well as proofrolling and mitigation of unsuitable areas delineated by the proofroll.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. In areas of foundation excavations, the bearing subgrade should be evaluated by the Geotechnical Engineer. If unanticipated conditions are observed, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Construction Adjacent to Existing Building

Care should be taken to ensure excavations for the new building will not affect the foundations and structural integrity of the existing building to the north. Although separate structures, these buildings are close enough in proximity that existing foundations could experience additional settlement. Underground piping between the two structures should be designed with flexible couplings and utility knockouts in foundation walls should be oversized so minor deflections in alignment do not result in breakage or distress. Care should be taken during excavation adjacent to existing foundations to avoid disturbing existing foundation bearing soils.

New footings should bear at or near the bearing elevation of immediately adjacent existing foundations. Depending upon their locations and current loads on the existing footings, footings for the new addition could cause settlement of adjacent walls. To reduce this concern and risk, clear distances at least equal to the new footing widths should be maintained between the new building's footings and footings supporting the existing building to the north.

Ground Improvement

As an alternative to supporting the structure on deep foundations, it may be feasible to support the building on a ground improvement system (such as stone columns or aggregate piers). Ground improvement methods are proprietary systems designed by licensed contractors, and these firms should be consulted to evaluate the feasibility of a ground improvement system for this project and provide further information regarding support options. The design-build contractor firm would develop the necessary design parameters for the planned foundation system including, but not limited to, allowable bearing capacity, settlement estimates and foundation-specific earthwork recommendations.

Deep Foundations

The parameters below are intended to provide a summary and model of the soil conditions. Individual borings may vary slightly in stratigraphy depth and material. Terracon should be retained to confirm the rock quality designation of the pier end bearing material.

Drilled Shaft Design Parameters

Soil design parameters are provided below in the **Drilled Shaft Design Summary** table for the design of drilled shaft foundations. The values presented for allowable side friction and end bearing include a factor of safety.

Drilled Shaft Design Summary ¹

Depth (feet)	Stratigraphy ²		Allowable Skin Friction (psf) ³	Allowable End Bearing Pressure (psf) ⁴
	No.	Material		
0 - 10	1	Lean Clay	Ignore	Ignore
10 - 25	2	Fat Clay	Ignore	Ignore
25+	4	Limestone Bedrock	3,000	40,000

1. Design capacities are dependent upon the method of installation and quality control parameters. The values provided are estimates and should be verified when installation protocol have been finalized.
2. See Subsurface Profile in [Geotechnical Characterization](#) for more details on stratigraphy.
3. Applicable for compressive loading only. The effective weight of the shaft can be added to uplift load resistance to the extent permitted by IBC.
4. Shafts should extend at least one diameter into the bearing stratum for end bearing to be considered.

Shafts should be adequately reinforced as designed by the Structural Engineer for both tension and shear to sufficient depths. Buoyant unit weights of the soil and concrete should be used in the calculations below the highest anticipated groundwater elevation.

Drilled shaft should have a minimum (center-to-center) spacing of three diameters. Closer spacing may require a reduction in axial load capacity. Axial capacity reduction can be determined by comparing the allowable axial capacity determined from the sum of individual piles in a group versus the capacity calculated using the perimeter and base of the pile group acting as a unit. The lesser of the two capacities should be used in design.

A minimum shaft diameter of 30 inches should be used. The drilled shafts should have a minimum length of three times the diameter and should extend at least 2 feet into the shale bedrock bearing strata for the allowable end-bearing pressure listed in the above table.

Post-construction settlements of a drilled shaft designed and constructed as described in this report are estimated to be on the order of ½ to 1 inch. Differential settlement between individual shafts is expected to be ½ to ⅔ of the total settlement.

Drilled Shaft Lateral Resistance

The following table lists input values for use in LPILE analyses to evaluate resistance of drilled shafts to lateral loads. Modern versions of LPILE provide estimated default values of k_h and E_{50} based on strength and are recommended for the project. Since deflection or a service limit criterion will most likely control lateral capacity design, no safety/resistance factor is included with the parameters.

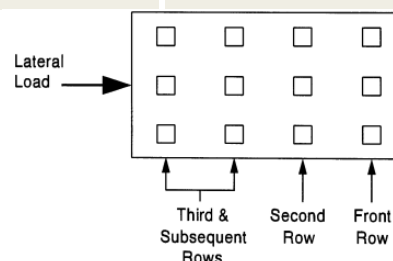
Stratigraphy ¹		LPILE Soil Model	S_u (psf) ²	ϕ ²	γ' (pcf) ²	E_{50}	K (pci)	
Depth	Material						Static	Cyclic
0 - 10	Clay and Gravelly Clay	Stiff Clay w/o Free Water	1,500	---	120	Use Default Value		
10 - 25	Clay and Gravelly Clay	Stiff Clay w/o Free Water	1,250	---	120	Use Default Value		
25+	Limestone	Strong Rock	5,000 psi ³	---	150	Not applicable for LPILE Strong Rock model		

1. See Subsurface Profile in [Geotechnical Characterization](#) for more details on Stratigraphy.
2. Definition of Terms:
 S_u : Undrained shear strength
 ϕ : Internal friction angle
 γ' : Effective unit weight
3. For the LPILE strong rock model, the unconfined compressive strength (given here in psi) is input instead of the undrained shear strength.

When shafts are used in groups, the lateral capacities of the shafts in the second, third, and subsequent rows of the group should be reduced as compared to the capacity of a single, independent shaft. Guidance for applying p-multiplier factors to the p values in the p-y curves for each row of pile foundations within a pile group are as follows:

Center to Center Pile Spacing ^{1,2}	P-Multiplier, P_m ³		
	Front Row	Second Row	Third and Subsequent Rows
3B	0.8	0.4	0.3
4B	0.9	0.65	0.5
5B	1.0	0.85	0.7
6B	1.0	1.0	1.0

1. Spacing in the direction of loading. B = pile diameter
2. For the case of a single row of piles supporting a laterally loaded grade beam, group action for lateral resistance of piles would need be considered when spacing is less than three pile diameters (measured center-to-center).



3. See adjacent figure for definition of front, second and third rows.

Spacing closer than 3D (where D is the diameter of the shaft) is not recommended without additional geotechnical consultation due to potential for the installation of a new shaft disturbing an adjacent installed shaft likely resulting in axial capacity reduction.

Drilled Shaft Construction Considerations

The drilling contractor should be experienced in the subsurface conditions observed at the site, and the excavations should be performed with equipment capable of providing a clean bearing surface. The drilled straight-shaft foundation system should be installed in general accordance with the procedures presented in "Standard Specification for the Construction of Drilled Piers", ACI Publication No. 336.1-01.

The contractor is generally expected to use conventional "dry" techniques for installation of the drilled shaft. Subsurface water was encountered in the borings during the drilling activities. Casing or slurry drilling procedures could be required to reduce the potential for excavation sidewall collapse.

The drilling contractor should remove all soft and disturbed soils from the base of the drilled pier prior to placing concrete. The drilled shaft installation process should be performed under the observation of the Geotechnical Engineer. The Geotechnical Engineer should document the shaft installation process including soil/rock and groundwater conditions observed, consistency with expected conditions, and details of the installed shaft.

Weak soils as well as bedrock were observed in the borings. To prevent collapse of the sidewalls and/or to control groundwater seepage, the use of temporary steel casing and/or slurry drilling procedures may be required for construction of the drilled shaft foundations. Significant seepage could occur in case of excavations penetrating water-bearing sandy soil and/or highly broken bedrock layers. The drilled shaft contractor and foundation design engineer should be informed of these risks.

A full-depth temporary steel casing may be required to shore the sides of the shaft excavations in the overburden. Difficult drilling conditions should be expected within both the sand layers above the bedrock and in the weathered bedrock, and the potential for hard bedrock drilling conditions should also be anticipated. If casing is removed during concrete placement, care should be exercised to maintain concrete inside the casing at a sufficient level to resist earth and hydrostatic pressures present on a casing exterior. Water or loose soil should be removed from the bottom of the drilled shafts prior to placement of the concrete.

Use of a telescoping casing arrangement can be considered to avoid handling long casing lengths. The lower casing should be of sufficient length and stiffness and have an appropriate cutting edge to allow it to be firmly seated into the bedrock to seal out groundwater. If possible, excess water should be evacuated from the casing to place concrete in the "dry."

Care should be taken to not disturb the sides and bottom of the excavation during construction. The bottom of the shaft excavation should be free of loose material before concrete placement. Concrete should be placed as soon as possible after the foundation excavation is completed, to reduce potential disturbance of the bearing surface.

While withdrawing casing, care should be exercised to maintain concrete inside the casing at a sufficient level to resist earth and hydrostatic pressures acting on the casing exterior. Arching of the concrete, loss of seal and other problems can occur during casing removal and result in contamination of the drilled shaft. These conditions should be considered during the design and construction phases. Placement of loose soil backfill should not be permitted around the casing prior to removal.

The drilled shaft installation process should be performed under the observation of the Geotechnical Engineer. The Geotechnical Engineer should document the shaft installation process including soil/rock and groundwater conditions observed, consistency with expected conditions, and details of the installed shaft.

Floor Slabs

Grade supported floor slabs appear feasible for the proposed building. Existing fill materials and materials described as possible fill were encountered at the site to depths

of 8 to 10 feet below existing grade. As previously described, any existing fill present beneath floor slabs should be removed at least 3 feet below the planned FFE and at that depth further evaluated by Terracon.

Due to the presence of moderate to high plasticity clay soils, we recommend the upper 24-inches of materials below the floor slab area consist of low volume change materials as described in [Earthwork](#).

Design parameters for floor slabs assume the requirements for [Earthwork](#) have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor Slab Support¹	At least 24 inches of low volume change (LVC) material
Granular Leveling Course Layer Thickness^{2, 3}	4 inches (minimum)
Estimated Modulus of Subgrade Reaction⁴	100 pounds per square inch per inch (psi/in) for point loads

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Well graded crushed stone (e.g., MoDOT Type 5) or open-graded crushed stone (e.g., ASTM C33, Size No. 57 aggregate) can be used as the leveling course.
3. These granular materials can be considered part of the LVC zone.
4. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in [Earthwork](#), and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, when the project includes humidity-controlled areas, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Joints should be placed in slabs at regular intervals as recommended by ACI to help control the locations of cracks. Joints or any cracks that develop in the floor slab should be sealed with a waterproof, non-extruding compressible compound.

If floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing, or other means.

Settlement of floor slabs supported on existing fill materials cannot be accurately predicted but could be larger than normal and result in some cracking. Mitigation measures, as noted in **Earthwork**, are critical to the performance of floor slabs. In addition to the mitigation measures, the floor slab can be stiffened by adding steel reinforcement, grade beams and/or post-tensioned elements.

Floor Slab Construction Considerations

The subgrade should be maintained within the moisture content range recommended for engineered fill until the floor slab is constructed. If the subgrade becomes desiccated prior to construction of the floor slab, the affected material should be removed or the materials should be scarified, moistened, and compacted. Upon completion of grading operations in the building area, care should be taken to maintain the subgrade within the moisture content and density ranges recommended for engineered fill prior to construction of the building floor slab.

On most project sites, the site grading is generally accomplished early in the construction phase. However, as construction proceeds, the subgrade may be disturbed due to utility excavations, construction traffic, desiccation, rainfall etc. As a result, the floor slab subgrade soils may not be suitable for placement of the granular course and/or concrete at the time of building construction, and corrective action may be required.

The Geotechnical Engineer should observe the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration.

Variations will occur between boring locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Support of floor slabs above existing fill is discussed in this report. Even with the construction observation/testing recommended in this report, the owner must accept the risk that unsuitable materials within or buried by the fill will not be discovered. This may result in larger than normal settlement and damage to slabs supported above existing fill, requiring additional maintenance. This risk cannot be eliminated without removing the existing fill from below the building and pavement areas, but it can be reduced by thorough observation and testing as discussed herein.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials, or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, cost estimating, excavation support, and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on

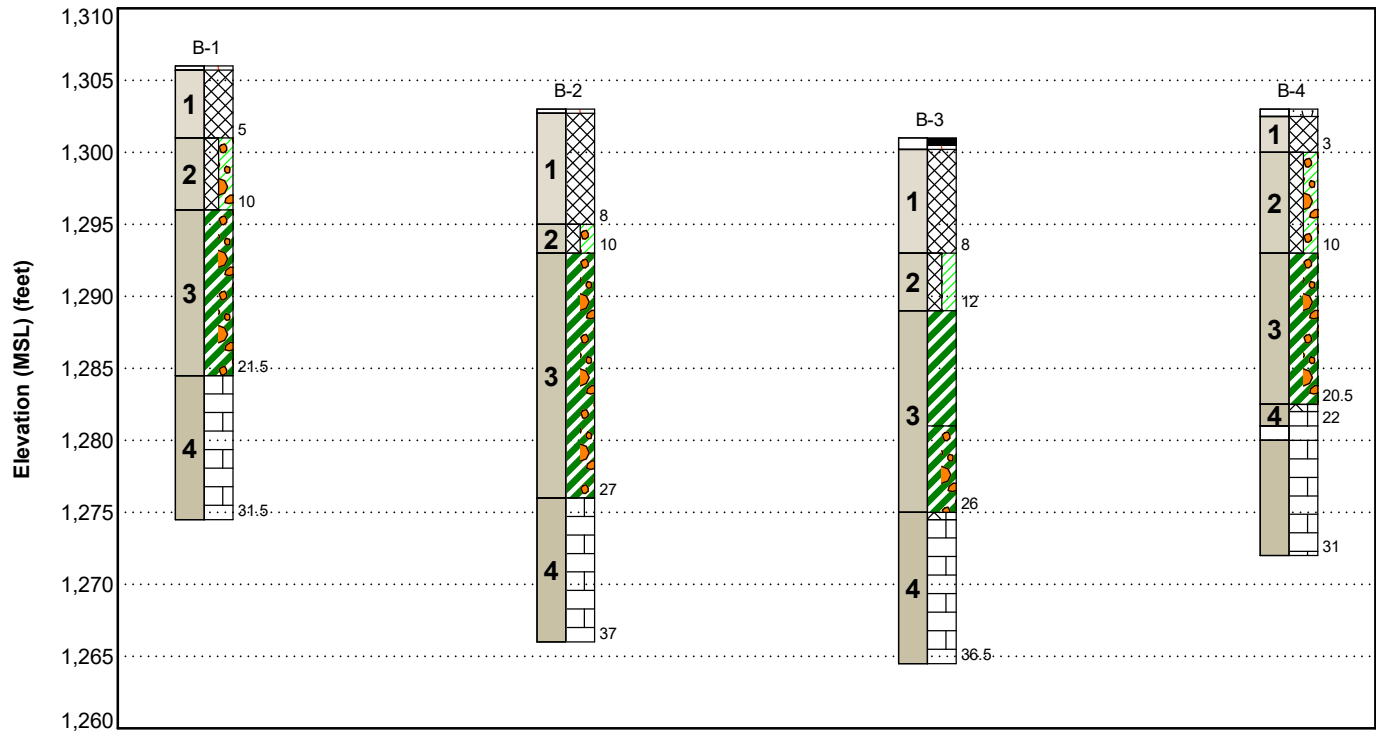
nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Figures

Contents:

GeoModel

GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	Fill Material	Brown lean clay fill material with varying amounts of gravel
2	Lean Clay	Brown and red brown lean clay with varying amounts of gravel. Possible fill material
3	Fat Clay	Red brown fat clay with varying amounts of gravel and sand
4	Limestone	Limestone bedrock with varying degrees of weathering

LEGEND

Aggregate Base Course	Fat Clay with Gravel	Lean Clay	Topsoil
Fill	Limestone	Fat Clay	
Lean Clay with Gravel	Asphalt	Weathered Limestone	

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project. Numbers adjacent to soil column indicate depth below ground surface.

Geotechnical Engineering Report

Art Annex Building | Springfield, Missouri

November 14, 2023 | Terracon Project No. B5235061



Attachments

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
4	31 to 37	Within the proposed building area

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ± 10 feet) and referencing existing site features. Approximate ground surface elevations were estimated using Google Earth.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using continuous flight augers. Samples were obtained from the borings using split-barrel sampling procedures. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. The borings were backfilled with bentonite chips after their completion. The upper few inches of borehole penetrations through pavements were surface patched with cold-mix asphalt and/or pre-mixed concrete.

We also observed the boreholes while drilling for the presence of groundwater. Groundwater was not observed in the boreholes at these times.

Our exploration team prepared field boring logs to record the sampling depths, penetration distances, other sampling information, visual classifications of the materials observed during drilling, and our interpretation of the subsurface conditions between samples. The samples were placed in appropriate containers and taken to our laboratory for testing and classification. The final boring logs provided with this report include modifications based on the results of the laboratory tests and observations of the recovered samples.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following tests on selected samples:

- Moisture Content
- Atterberg Limits
- Grain Size Distribution
- Unconfined Compressive Strength of Rock

The laboratory testing program included examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we described and classified the soil samples in general accordance with the Unified Soil Classification System.

Rock classification was conducted using locally accepted practices for engineering purposes; core samples and petrographic analysis may indicate other rock types. The rock classifications on the boring logs were determined using the attached Rock Classification Notes.

Rock Core Photography Log



Boring B-1



Boring B-2

Geotechnical Engineering Report

Art Annex Building | Springfield, Missouri

November 14, 2023 | Terracon Project No. B5235061



Boring B-3



Boring B-4

Site Location and Exploration Plans

Contents:

Site Location Plan

Exploration Plan

Note: All attachments are one page unless noted above.

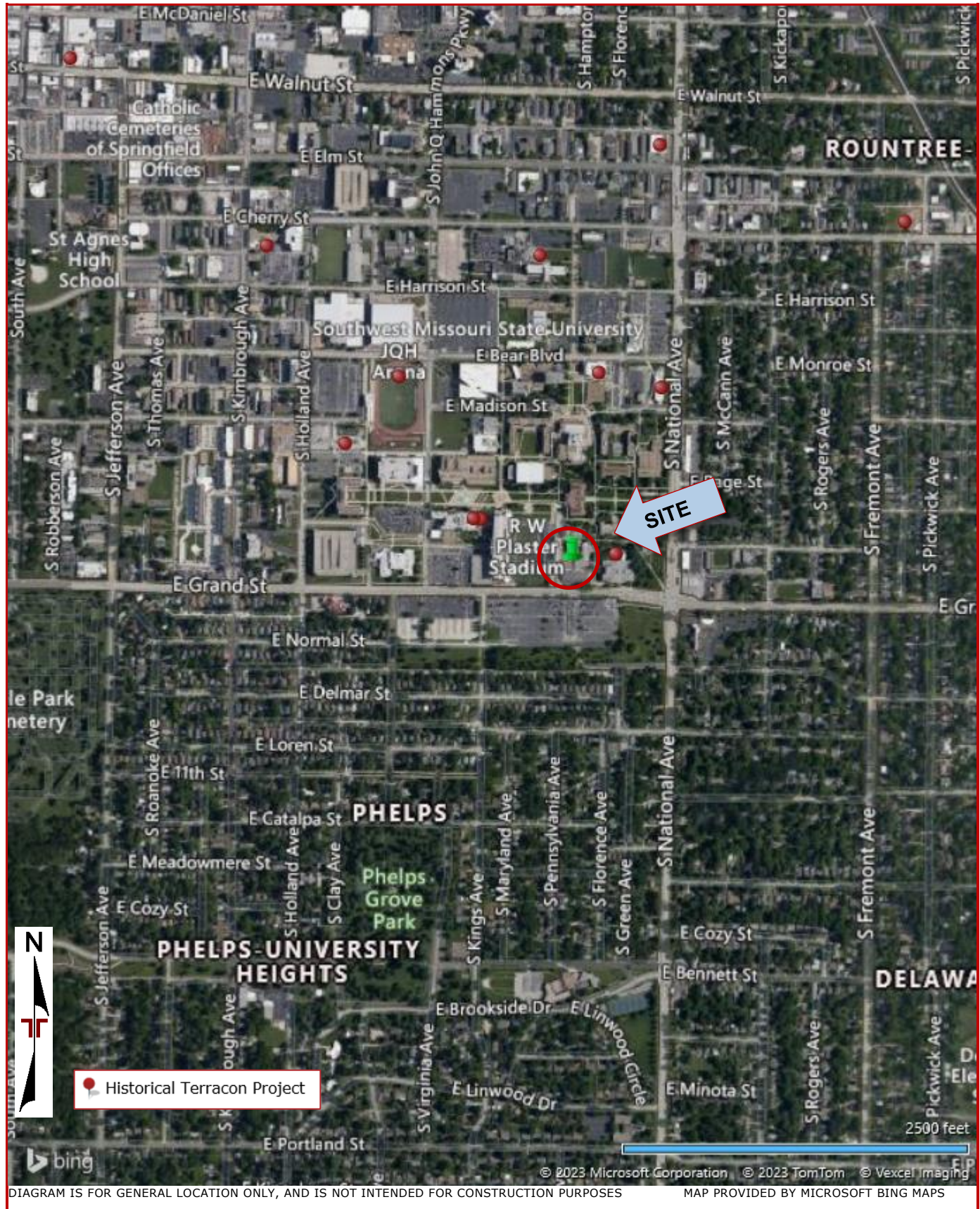
Geotechnical Engineering Report

Art Annex Building | Springfield, Missouri

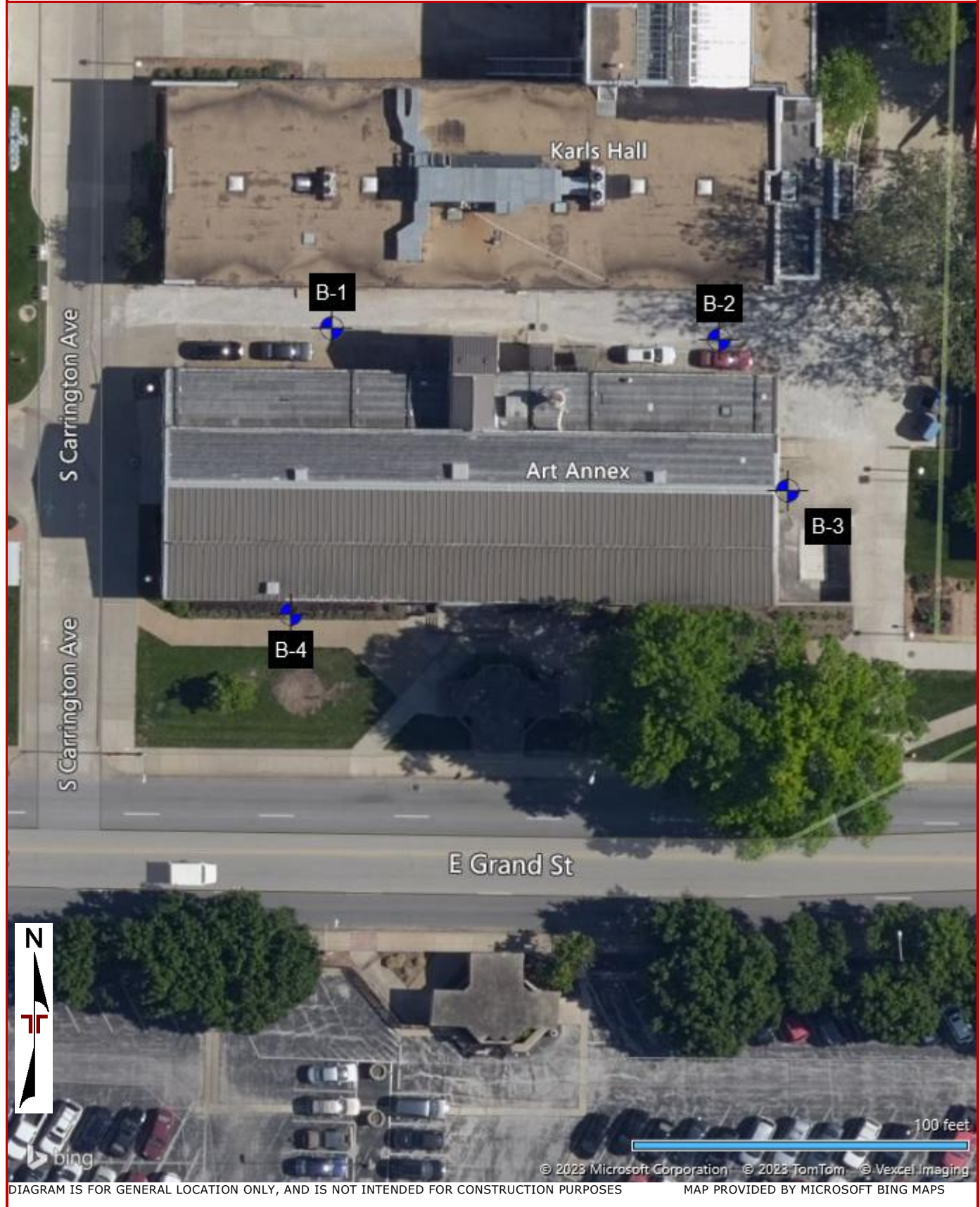
November 14, 2023 | Terracon Project No. B5235061



Site Location



Exploration Plan



Exploration and Laboratory Results

Contents:

Boring Logs (B-1 through B-4)
Unconfined Compressive Strength of Rock
Atterberg Limits
Grain Size Distribution

Note: All attachments are one page unless noted above.

Boring Log No. B-1

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 37.1972° Longitude: -93.2788° Depth (Ft.) Elevation: 1306 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits
									LL-PL-PI
		0.3 AGGREGATE BASE COURSE (4") FILL - LEAN CLAY WITH GRAVEL , silty, brown	1305.7						
1		5.0	1301		X	8	3-2-3 N=5	22.8	
					X	8	3-4-4 N=8	23.4	36-20-16
2		LEAN CLAY WITH GRAVEL (CL) , possible fill, brown to red brown, stiff to very stiff			X	12	8-6-7 N=13	22.1	39-17-22
		10.0	1296		X	18	6-8-10 N=18	45.1	
		FAT CLAY WITH GRAVEL (CH) , red brown, soft to stiff			X	18	3-4-5 N=9	52.0	
3		21.5	1284.5		X	8	1-1-1 N=2	73.2	
		LIMESTONE , with chert, grey							
4		31.5	1274.5				REC: 100% RQD: 88%		
		Boring Terminated at 31.5 Feet							

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were estimated using Google Earth

Water Level Observations
Groundwater not encountered

Drill Rig
#546
Hammer Type
Automatic
Driller
AL

Advancement Method
4" continuous flight auger, then NQ rock core

Abandonment Method
Boring backfilled with bentonite chips upon completion.

Logged by
EF
Boring Started
10-27-2023
Boring Completed
10-27-2023

Boring Log No. B-2

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 37.1972° Longitude: -93.2784° Depth (Ft.) Elevation: 1303 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits
									LL-PL-PI
1		0.3 AGGREGATE BASE COURSE (4") 1302.7							
		FILL - LEAN CLAY WITH GRAVEL , brown							
		possible red brick fill at 6'							
2		8.0 LEAN CLAY WITH GRAVEL (CL) , possible fill, brown to red brown, very stiff 1295							
		10.0 FAT CLAY WITH GRAVEL (CH) , red brown, medium stiff to stiff 1293							
3									
4									
		27.0 LIMESTONE , with chert, grey 1276							
		37.0 Boring Terminated at 37 Feet 1266							

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were estimated using Google Earth

Water Level Observations
Groundwater not encountered

Advancement Method
4" continuous flight auger, then NQ rock core

Abandonment Method
Boring backfilled with bentonite chips upon completion.

Drill Rig
#546

Hammer Type
Automatic

Driller
AL

Logged by
EF

Boring Started
10-27-2023

Boring Completed
10-27-2023

Boring Log No. B-3

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 37.1970° Longitude: -93.2783° Depth (Ft.) Elevation: 1301 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits
									LL-PL-PI
		0.5 ASPHALT (6") 1300.5							
		0.8 AGGREGATE BASE COURSE (4") 1300.2							
		FILL - LEAN CLAY WITH GRAVEL , brown							
1			5						
				X	6	16-21-18 N=39	23.0		
				X	6	12-13-14 N=27	14.5		
				X	12	4-5-7 N=12	20.2		
		8.0 1293							
2		LEAN CLAY (CL) , possible fill, brown to red brown, very stiff	10						
				X	16	10-11-13 N=24	18.1		42-21-21
		12.0 1289							
		FAT CLAY (CH) , trace sand and gravel, red brown, medium stiff to stiff	15						
				X	16	4-5-7 N=12	34.1		
3			20						
		20.0 1281							
		FAT CLAY WITH GRAVEL (CH) , red brown, hard	25						
				X	18	3-3-4 N=7	54.6		
		26.0 1275							
		26.5 WEATHERED LIMESTONE 1274.5							
		LIMESTONE , with chert, grey	30						
4									
							REC: 100% RQD: 78%		
		36.5 1264.5							
		Boring Terminated at 36.5 Feet							

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were estimated using Google Earth

Water Level Observations
Groundwater not encountered

Advancement Method
4" continuous flight auger, then NQ rock core

Abandonment Method
Boring backfilled with bentonite chips upon completion.

Drill Rig
#546

Hammer Type
Automatic

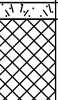



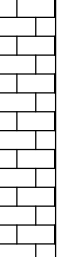
Driller
AL

Logged by
EF

Boring Started
10-30-2023

Boring Completed
10-30-2023

Boring Log No. B-4

Model Layer	Graphic Log	Location: See Exploration Plan			Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits
		Latitude: 37.1969° Longitude: -93.2788°									LL-PL-PI
		Depth (Ft.)	Elevation: 1303 (Ft.) +/-								
		0.5	1302.5								
1		TOPSOIL (6")									
			FILL - LEAN CLAY WITH GRAVEL , brown								
		3.0	1300								
2		LEAN CLAY WITH GRAVEL (CL) , possible fill, brown to red brown, stiff to hard									
		10.0	1293								
3		FAT CLAY WITH GRAVEL (CH) , red brown, medium stiff to very stiff									
		20.5	1282.5								
4		WEATHERED LIMESTONE									
		21.0	1282								
		22.0	1281								
		23.0	1280								
			VOID/CLAY SEAM								
			LIMESTONE , with chert, grey								
		31.0	1272								
		Boring Terminated at 31 Feet									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were estimated using Google Earth

Water Level Observations

Groundwater not encountered

Drill Rig
#546

Hammer Type
Automatic

Driller
AL

Logged by
EF

Advancement Method

4" continuous flight auger, then NQ rock core

Abandonment Method

Boring backfilled with bentonite chips upon completion.

Boring Started
10-26-2023

Boring Completed
10-26-2023

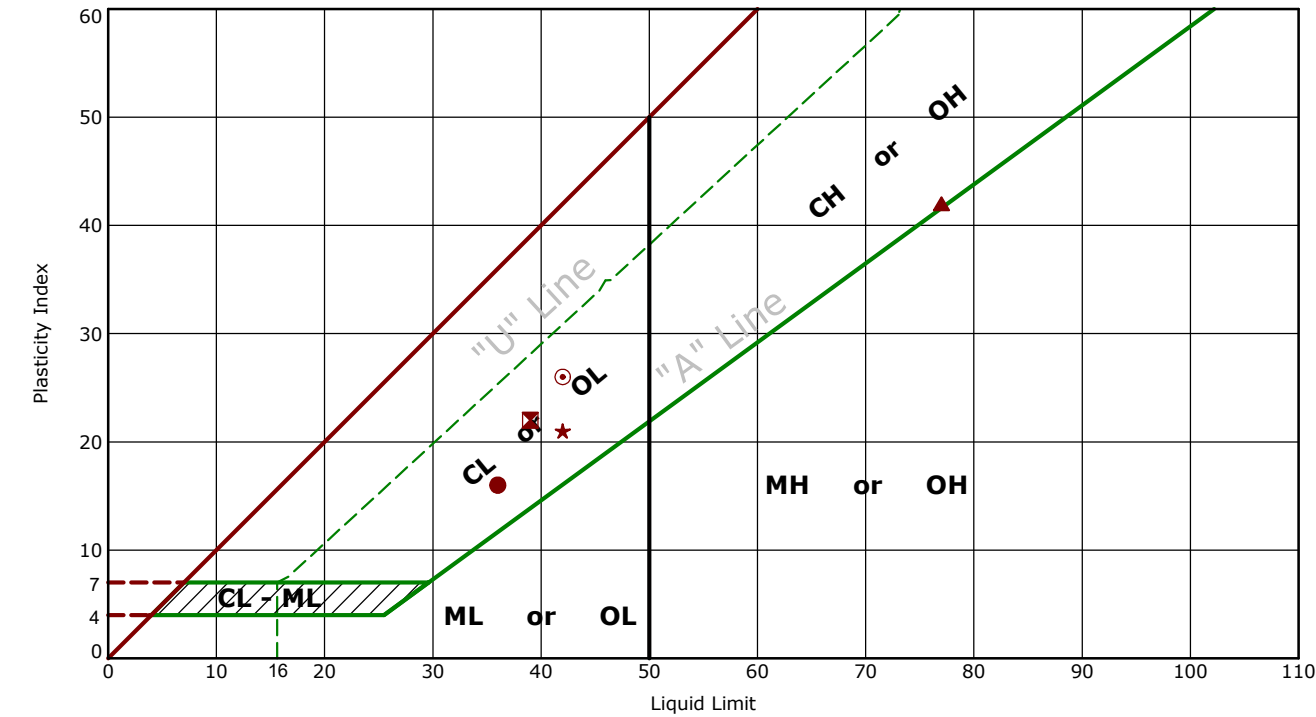
Unconfined Compressive Strength of Rock Results

Four (4) compressive strength tests were performed on rock cores. Please reference the table below for information regarding rock core breaks within selected borings (elevations and boring depths are in feet).

Boring #	Rock Break Depth (ft)	Q _u (ksf)
B-1	22-22.4	573
B-2	31.7-32	565
B-3	28.1-28.4	798
B-4	23.6-23.9	783

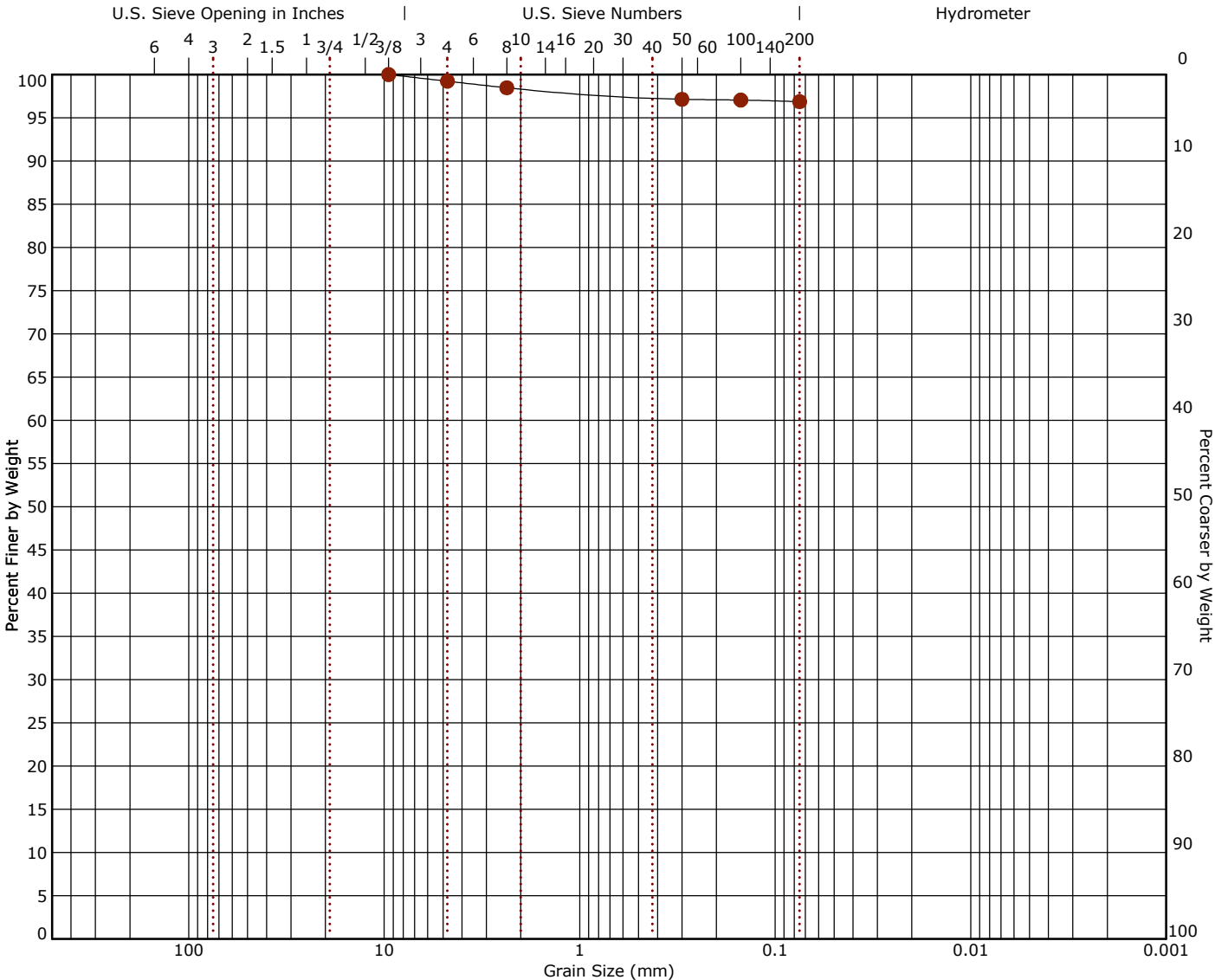
Atterberg Limit Results

ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-1	3.5 - 5	36	20	16		CL	Lean Clay with Gravel
⊠	B-1	6 - 7.5	39	17	22		CL	Lean Clay with Gravel
▲	B-2	13.5 - 15	77	35	42		CH	Fat Clay with Gravel
★	B-3	8.5 - 10	42	21	21		CL	Lean Clay
⊙	B-4	3.5 - 5	42	16	26		CL	Lean Clay with Gravel

Grain Size Distribution
ASTM D422 / ASTM C136



Cobbles		Gravel		Sand			Silt or Clay						
		coarse	fine	coarse	medium	fine							
Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS					
<div></div> B-3	13.5 - 15	0.0	0.8	2.4	96.9			CH					
Description				<div></div>				Grain Size					
<div></div> Fat Clay				Sieve	% Finer	Sieve	% Finer	Sieve	% Finer		<div></div>		
				3/8"	100.0					D ₆₀			
				#4	99.24					D ₃₀			
				#100	98.47					D ₁₀			
				#200	97.14								
				97.05									
					96.87								
Remarks										Coefficients			
<div></div>											<div></div>		
											C _c		
											C _u		









Supporting Information

Contents:

General Notes
Unified Soil Classification System
Rock Classification Notes

Note: All attachments are one page unless noted above.

General Notes

Sampling	Water Level	Field Tests
 Auger Cuttings  Grab Sample  Shelby Tube  Split Spoon	 Water Initially Encountered  Water Level After a Specified Period of Time  Water Level After a Specified Period of Time  Cave In Encountered <p>Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.</p>	N Standard Penetration Test Resistance (Blows/Ft.) (HP) Hand Penetrometer (T) Torvane (DCP) Dynamic Cone Penetrometer UC Unconfined Compressive Strength (PID) Photo-Ionization Detector (OVA) Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		Consistency of Fine-Grained Soils (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Relative Density	Standard Penetration or N-Value (Blows/Ft.)	Consistency	Unconfined Compressive Strength Qu (tsf)	Standard Penetration or N-Value (Blows/Ft.)
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification		
				Group Symbol	Group Name ^B	
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	Gravels: More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels: Less than 5% fines ^C	$Cu \geq 4$ and $1 \leq Cc \leq 3$ ^E	GW	Well-graded gravel ^F	
		Gravels with Fines: More than 12% fines ^C	$Cu < 4$ and/or $[Cc < 1 \text{ or } Cc > 3.0]$ ^E	GP	Poorly graded gravel ^F	
			Fines classify as ML or MH	GM	Silty gravel ^{F, G, H}	
			Fines classify as CL or CH	GC	Clayey gravel ^{F, G, H}	
	Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines ^D	$Cu \geq 6$ and $1 \leq Cc \leq 3$ ^E	SW	Well-graded sand ^I	
		Sands with Fines: More than 12% fines ^D	$Cu < 6$ and/or $[Cc < 1 \text{ or } Cc > 3.0]$ ^E	SP	Poorly graded sand ^I	
			Fines classify as ML or MH	SM	Silty sand ^{G, H, I}	
			Fines classify as CL or CH	SC	Clayey sand ^{G, H, I}	
Fine-Grained Soils: 50% or more passes the No. 200 sieve	Silts and Clays: Liquid limit less than 50	Inorganic:	$PI > 7$ and plots above "A" line ^J	CL	Lean clay ^{K, L, M}	
			$PI < 4$ or plots below "A" line ^J	ML	Silt ^{K, L, M}	
		Organic:	$\frac{LL \text{ oven dried}}{LL \text{ not dried}} < 0.75$	OL	Organic clay ^{K, L, M, N} Organic silt ^{K, L, M, O}	
			Silts and Clays: Liquid limit 50 or more	Inorganic:	PI plots on or above "A" line	CH
	PI plots below "A" line	MH			Elastic silt ^{K, L, M}	
	Organic:	$\frac{LL \text{ oven dried}}{LL \text{ not dried}} < 0.75$		OH	Organic clay ^{K, L, M, P} Organic silt ^{K, L, M, Q}	
		Highly organic soils:		Primarily organic matter, dark in color, and organic odor		PT

^A Based on the material passing the 3-inch (75-mm) sieve.

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

^D Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

$$^E \quad Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

^F If soil contains $\geq 15\%$ sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, add "with organic fines" to group name.

^I If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

^L If soil contains $\geq 30\%$ plus No. 200 predominantly sand, add "sandy" to group name.

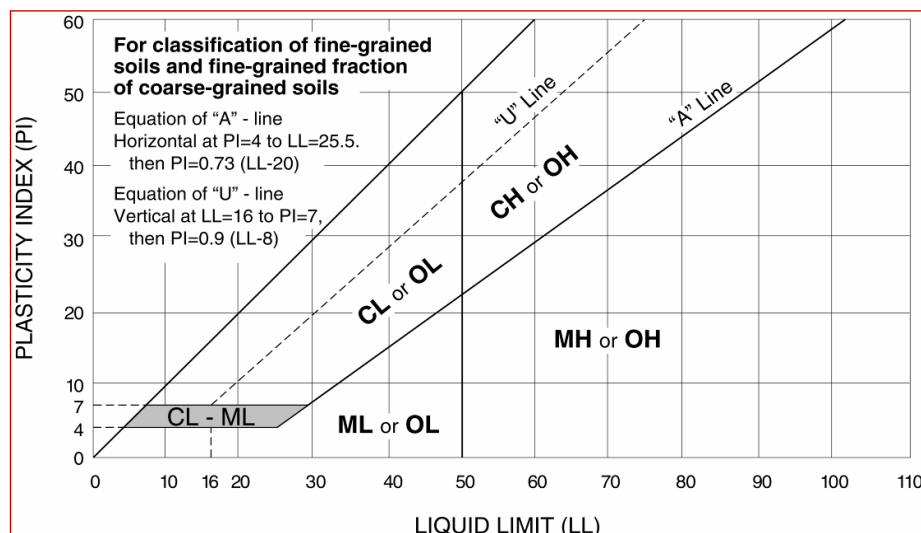
^M If soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.

^N $PI \geq 4$ and plots on or above "A" line.

^O $PI < 4$ or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.



Rock Classification Notes

WEATHERING			
Term	Description		
Fresh	Mineral crystals appear bright; show no discoloration. Features show little or now staining on surfaces. Discoloration does not extend into intact rock.		
Slightly weathered	Rock generally fresh except along fractures. Some fractures stained and discoloration may extend <0.5 inches into rock.		
Moderately weathered	Significant portions of rock are dull and discolored. Rock may be significantly weaker than in fresh state near fractures. Soil zones of limited extent may occur along some fractures.		
Highly weathered	Rock dull and discolored throughout. Majority of rock mass is significantly weaker and has decomposed and/or disintegrated; isolated zones of stronger rock and/or soil may occur throughout.		
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The rock mass or fabric is still evident and largely intact. Isolated zones of stronger rock may occur locally.		
STRENGTH OR HARDNESS			
Description	Field Identification	Uniaxial Compressive Strength, psi	
Extremely strong	Can only be chipped with geological hammer. Rock rings on hammer blows. Cannot be scratched with a sharp pick. Hand specimens require several hard hammer blows to break.	>36,000	
Very strong	Several blows of a geological hammer to fracture. Cannot be scratched with a 20d common steel nail. Can be scratched with a geologist’s pick only with difficulty.	15,000-36,000	
Strong	More than one blow of a geological hammer needed to fracture. Can be scratched with a 20d nail or geologist’s pick. Gouges or grooves to ¼ inch deep can be excavated by a hard blow of a geologist’s pick. Hand specimens can be detached by a moderate blow.	7,500-15,000	
Medium strong	One blow of geological hammer needed to fracture. Can be distinctly scratched with 20d nail. Can be grooved or gouged 1/16 in. deep by firm pressure with a geologist's pick point. Can be fractured with single firm blow of geological hammer. Can be excavated in small chips (about 1-in. maximum size) by hard blows of the point of a geologist’s pick;	3,500-7,500	
Weak	Shallow indent by firm blow with geological hammer point. Can be gouged or grooved readily with geologist's pick point. Can be excavated in pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.	700-3,500	
Very weak	Crumbles under firm blow with geological hammer point. Can be excavated readily with the point of a geologist's pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.	150-700	
DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		Bedding Spacing (May Include Foliation or Banding)	
Description	Spacing	Description	Spacing
Intensely fractured	< 2.5 inches	Laminated	< ½-inch
Highly fractured	2.5 – 8 inches	Very thin	½ – 2 inches
Moderately fractured	8 inches to 2 feet	Thin	2 inches – 1 foot
Slightly fractured	2 to 6.5 feet	Medium	1 – 3 feet
Very slightly fractured	> 6.5 feet	Thick	3 – 10 feet
		Massive	> 10 feet
ROCK QUALITY DESIGNATION (RQD) ¹			
Description		RQD Value (%)	
Very Poor		0 - 25	
Poor		25 – 50	
Fair		50 – 75	
Good		75 – 90	
Excellent		90 - 100	

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

GENERAL CONDITIONS

DEFINITIONS

ARTICLE 1 – DEFINITIONS

Wherever used in any of the Contract Documents, the following meanings shall be given the terms as herein defined:

A. "Administrative Review" means a non-judicial dispute resolution mechanism. Advisory arbitration conducted by an independent third party, as further described in the Resolution of Claims and Disputes Article contained herein, unless the parties agree in writing to an alternative mechanism.

B. "Agreement" means the contract executed by the Owner and the Contractor.

C. "Bidder" means an individual, firm, association or corporation submitting a bid proposal for the Work contemplated.

D. "Claim" shall mean a demand or assertion by the Contractor seeking, as a matter of right adjustment or interpretation of Contract terms, payment of money, extension of time or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question between the Owner and the Contractor arising out of or relating to the Agreement.

E. "Contract Documents" consist of the Agreement between the Owner and the Contractor (hereinafter the Agreement), the conditions of the Agreement (General, Supplementary and other Conditions), Advertisement for Bids, Notice to Contractors, Instructions to Bidders, Drawings, Specifications, Addenda issued prior to execution of the Agreement, Notice to Proceed, other documents listed in the Agreement, and Modifications issued after execution of the Agreement. A Modification is (1) a written amendment to the Agreement signed by both parties, (2) a Change Order, (3) a Construction Change Directive or (4) a written order for a minor change in the Work issued by the Consultant.

F. "Contractor" is the party or parties who have been awarded an Agreement to furnish work under these Contract Documents.

G. "Consultant" shall refer to the Architect, Engineer, or other design professional when employed by the University, or their duly authorized representative. When a consultant is not employed the Owner shall act as the Consultant.

H. "Debarment Official" shall mean the Vice President for Administrative Services or appointed representative of Missouri State University, Springfield, Missouri.

I. "Designated Representative" shall mean the person appointed by Owner to represent Owner on the Project.

J. "Director" shall mean the Director of Planning, Design and Construction or appointed representative of Missouri State University, Springfield, Missouri.

K. "Drawings" are the graphic and pictorial portions of the Contract Documents showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, schedules and diagrams.

L. "Final Completion" shall mean the date of the Owner's acceptance of the Work from the Contractor upon confirmation from the Consultant and the Contractor that the Work is entirely complete in accordance with the Contract Documents.

M. "Governing Law" – The law of the State of Missouri shall govern the construction of this Agreement, without regard to conflict of law principles.

N. "MBE" - Minority Business Enterprise, a business concern classified as a MBE by the State of Missouri, or another federal, state or local governmental agency.

O. "Owner" shall mean the Board of Governors, Missouri State University, acting by and through its duly appointed representatives in the department of Planning, Design and Construction, also referred to as "Missouri State University" or "University."

P. "Product Data" are illustrations, standard schedules, performance charts, instructions, brochures, diagrams, and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.

Q. "Project" –is the term meant to identify the Designer's work as identified in the Contract Documents.

R. "Project Manual" is a volume or volumes assembled for the Work that may include the bidding requirements, sample forms, conditions of the Agreement, and Specifications.

S. "Provide" shall mean furnish and install.

T. "Samples" are physical examples of actual materials, finishes, assemblies, trim, hardware, detailing, equipment, workmanship, etc. and establish a standard by which the Work will be judged.

U. "SDVE" – Service-Disabled Veteran Business Enterprise, a business concern classified as a SDVE by the State of Missouri, or another federal, state, or local government agency.

V. "Shop Drawings" are drawings, diagrams, schedules, and other data specifically for the Work by the Contractor or a Subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the Work.

W. "Similar" shall be used in its general sense and not as meaning identical, and all details shall be worked out in relation to their location and their connection to other parts of the Work.

X. "Specifications" are that portion of the Contract Documents consisting of the written requirements for materials, equipment, systems, standards and workmanship for the Work, and performance of related services.

Y. "Subcontractor" as employed herein, includes all those having a direct agreement with a Contractor for the furnishing of materials, labor, equipment and services to be used on this project.

Z. "Substantial Completion" or "Substantially Complete" shall mean the date when the Owner agrees that the Work, or specific portion thereof, is sufficiently complete in accordance with the Contract Documents, so that it can be utilized by the Owner for the purposes for which it was intended. The Owner at its sole discretion may take beneficial occupancy at this time or choose to wait to occupy until after Final Completion is achieved.

AA. "Superintendent" shall mean the person designated by Contractor to represent Contractor on the Project.

AB. "Time" – Time limits stated in the Contract Documents are of the essence of the Agreement.

AC. "Unit Prices" shall mean an amount included on the Bid Form which includes full compensation for all required labor, products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of an item of the Work; overhead and profit.

AD. "WBE" - Women Business Enterprise, a business concern classified as a WBE by the State of Missouri, or another federal, state, or local governmental agency.

AE. "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment and services provided

or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

GENERAL PROVISIONS

ARTICLE 2 – STATUTORY PREFERENCE

A. By virtue of Statutory authority a preference will be given to Missouri Labor and to products of mines, forests and quarries of the State of Missouri when they are found in marketable quantities in the state, and all such materials shall be of the best quality and suitable character that can be obtained at reasonable market prices, all as provided for in Sections 8.280 and 34.359 RSMo., and cumulative supplements, incorporated herein by reference.

B. The President of Missouri State University certifies that it is the policy of the University that no Contractor or vendor providing goods, commodities or services for purchase or lease will knowingly include or supply products manufactured outside the United States. Exceptions to this requirement are where it can be documented that said products are not manufactured in the United States in sufficient quantities to meet the contract requirements within the necessary time, or where obtaining products manufactured or assembled or produced in the United States would increase the cost of the Agreement by more than 10 percent. Any vendor or Contractor knowingly violating this provision shall be in violation of the terms and conditions of the Agreement, and subject to termination of the Agreement.

ARTICLE 3 – 'ANTI-KICK BACK'

A. The Contractor shall comply with all provisions of the Copeland 'Anti-Kick Back' Act (18 U.S.C. 874) as supplemented in Department of Labor Regulations (29 C.F.R., Part 3), incorporated herein by reference.

B. The Contractor hereby certifies that no person employed on the Work has been induced to or required to give up any part of the compensation to which he or she is otherwise entitled. The Contractor further certifies that it has not sought by collusion, payment to any person, or otherwise to obtain any advantage over the Owner or made any payment or promise of other consideration to the Owner or its agents to cause award of this Agreement to the Contractor.

ARTICLE 4 – TRANSIENT EMPLOYERS

A. Contractors must be registered and bonded with the Department of Revenue and Division of Employment Security. If requested, Contractors must provide proof of compliance with these conditions.

ARTICLE 5 – UNIVERSITY NON-DISCRIMINATION STATEMENT

A. Missouri State University is a community of people with respect for diversity. The University emphasizes the dignity and equality common to all persons and adheres to a strict nondiscrimination policy regarding the treatment of individual faculty, staff, and students. In accord with federal law and applicable Missouri statutes, the University does not discriminate on the basis of race, color, national origin (including ancestry, or any other subcategory of national origin recognized by applicable law), religion, sex (including marital status, pregnancy, sexual orientation, gender identity, gender expression, or any other subcategory of sex recognized by applicable law), age, disability, veteran status, genetic information, or any other basis protected by applicable law in employment or in any program or activity offered or sponsored by the University. Sex discrimination encompasses sexual harassment, which includes sexual violence, and is strictly prohibited by Title IX of the Education Amendments of 1972.

B. This policy shall not be interpreted in a manner as to violate the legal rights of religious organizations or military organizations associated with the Armed Forces of the United States of America.

C. The University maintains a grievance procedure incorporating due process available to any person who believes he or she has been discriminated against. Missouri State University is an Equal Opportunity/Affirmative Action/Minority/Female/Veterans/Disability/Sexual Orientation/Gender Identity employer. Inquiries concerning the complaint/grievance procedure related to sex discrimination, including

sexual harassment and sexual assault, should be addressed to the Title IX Coordinator, Carrington Hall 205, 901 S. National Ave., Springfield, Missouri 65897 or to the Office for Civil Rights. All other inquiries concerning the grievance procedure, Affirmative Action Plan, or compliance with federal and state laws and guidelines should be addressed to the Equal Opportunity Officer, Office for Institutional Equity and Compliance, Park Central Office Building, Suite 111, Springfield, Missouri 65897, equity@missouristate.edu, 417-836-4252, or to the Office for Civil Rights.

ARTICLE 6 – OWNERSHIP OF DRAWINGS

A. Drawings, specifications and other documents, including those in electronic form, prepared by the Consultant and/or their Consultants are Instruments of Service for use solely with respect to the Work. The Consultant and their Consultants shall be deemed the authors and owners of their respective Instruments of Service and shall retain all common law, statutory and other reserved rights, including copyrights.

ARTICLE 7 – CORRELATION AND INTENT OF THE CONTRACT DOCUMENTS

A. The Contract Documents are complementary and what is called for by any one document shall be as binding as if called for by all. The intention of the Contract Documents is to include all labor, materials, equipment, transportation, and everything else necessary to properly execute the Work. Materials or Work described in words that have a well-known technical or trade meaning shall refer to such recognized standards.

ARTICLE 8 – DRAWINGS, DETAILS, AND INSTRUCTIONS

A. The general character of the Work is shown on the Drawings. Where, on any Drawing, a portion of the Work is drawn out and the remainder of the Work is indicated in the Specifications, the parts drawn out shall apply to all other like portions of the Work. Where ornament or other detail is indicated, such detail shall be continued throughout the courses or parts of the Work in which it occurs and shall also apply to all other similar parts in the Work, unless otherwise indicated. In case of differences between small and large-scale Drawings, the larger scale Drawings shall take precedence. In the event of differences between the Specifications and the Drawings, the more restrictive shall take precedence.

ARTICLE 9 – ACCESS TO RECORDS AND REPORTS

A. Contractor agrees to provide Owner or any of Owner's duly appointed representatives with access to any books, documents, papers and records which are directly pertinent to this Agreement for the purposes of making audits, examinations, excerpts and transcriptions.

ADMINISTRATION OF THE AGREEMENT

ARTICLE 10 – COMMUNICATIONS

A. All correspondence, notices, invoices, demands, requests, instructions, approvals and claims must be in writing. All such documents shall include Missouri State University's project number. This number is listed within the Contract Documents. All papers required to be delivered to the Owner shall, unless otherwise specified by the Owner in writing to the contrary, be delivered to Planning, Design and Construction, Missouri State University, Springfield, Missouri. Notices shall be deemed to have been given at the time of actual receipt of the notice.

ARTICLE 11 – RIGHTS AND RESPONSIBILITIES OF CONSULTANT

A. The Consultant may, through the Owner's Designated Representative, give orders and directions relative to the execution of the Work, including deciding the meaning and intent of any portion of the Contract Documents which may be found obscure or in dispute, and all such directions, estimates, and decisions shall be final and conclusive. The Consultant shall determine the amount, quality, and acceptability of the Work and materials which are to be paid to the Contractor under this Agreement. In case any question shall arise between the parties hereto relative to the Contract Documents,

determination or decision of the Consultant shall be a condition precedent to the right of the Contractor to receive any money or payment for Work under the Agreement affected in any manner or to any extent by such question.

B. The Consultant, through the Director, may by written notice request a Contractor to remove from the Project any Contractor or Subcontractor's employees whom the Consultant or Director may deem incompetent, careless, or a hindrance to proper timely execution of the Work. The Contractor shall comply with such notice promptly and without detriment to the Work.

C. The Consultant, through the Director, or the Director may take appropriate action and issue instructions which, in their judgment, may be required to avoid unnecessary and unwarranted delay if the Contractors refuse to cooperate with the instructions and reasonable requests of the other Contractors performing work for the Owner under separate agreements.

ARTICLE 12 – CONTRACTOR PERFORMANCE EVALUATION

A. Planning, Design and Construction tracks Contractor performance related to contracts bid and work managed by this department. Contractors shall be recognized for outstanding performance as well as less than satisfactory performance. Each Contractor performing services for Missouri State University shall be subject to performance evaluations. Performance evaluations are a key component in determining Contractor responsiveness and may be used by Missouri State University in the review of a Contractor's suitability as the lowest, responsive, responsible bidder for future work.

B. The performance criteria are included in the Contractor Performance Evaluation form following in Appendix A so that all Contractors are aware of the criteria prior to beginning a project. Upon Final Completion of a project, the Project Manager, along with other University personnel, shall complete a performance evaluation for all prime Contractors. Planning, Design and Construction shall provide the Contractor a signed completed evaluation form pertaining to their Agreement.

C. Any Contractor who wishes to contest any information contained in the evaluation form may submit a written response no later than thirty (30) days after the date the form was mailed (as indicated by the postmark on the envelope) or emailed (as indicated on the dated email). The Contractor's written response to a performance evaluation, as well as any subsequent written communication with regard to the performance evaluation, shall be reviewed and become a part of the Contractor's evaluation file.

D. At the discretion of the Project Manager, a periodic evaluation may be completed for any Contractor when a serious concern regarding their performance on the Project exists.

ARTICLE 13 – CLAIMS AND DISPUTES

A. Claims must be formally submitted to Planning, Design and Construction. The responsibility to substantiate Claims shall rest with the Contractor.

B. Claims, including those alleging an error or omission by the Consultant shall be referred initially to the University's Designated Representative for action. A recommendation by the Consultant shall be required as a condition precedent to Administrative Review or litigation of a Claim between the Contractor and the Owner as to all such matters arising prior to the date final payment is due, regardless of any of the following:

- (1) Whether such matters relate to execution and progress of the Work.
- (2) The extent to which the Work has been completed.

The recommendation by the Consultant in response to a Claim shall not be a condition precedent to Administrative Review or litigation in the event:

- (1) The position of Consultant is vacant,
- (2) The Consultant has not received evidence or has failed to render a recommendation

within agreed time limits,

- (3) The Consultant has failed to take action required under the Resolution of Claims and Disputes Article within thirty (30) calendar days after the Claim is made,
- (4) Forty-five (45) calendar days have passed after the Claim has been referred to the Consultant.

C. Claims must be made within twenty-one (21) calendar days after occurrence of the event giving rise to such Claim or within twenty-one (21) calendar days after the claimant first recognizes the condition giving rise to the Claim, whichever is later. An additional Claim made after the initial Claim has been implemented by Change Order will not be considered.

D. Pending final resolution of a Claim including Administrative Review, unless otherwise agreed in writing, the Contractor shall proceed diligently with performance of the Agreement and the Owner shall continue to make payments in accordance with the Contract Documents.

E. The making of final payment shall constitute a waiver of Claims by the Owner except those arising from any of the following:

- (1) Claims, security interests or encumbrances arising out of the Agreement and unsettled;
- (2) Failure of the Work to comply with the requirements of the Contract Documents;
- (3) Terms of special warranties required by the Contract Documents.

F. If concealed or unknown conditions are encountered at the site which are:

- (1) Subsurface or otherwise concealed physical conditions which differ materially from those indicated in the Contract Documents, or
- (2) Unknown physical conditions of an unusual nature, which differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents,

then notice by the Contractor shall be given to the Consultant through the Director promptly before conditions are disturbed and in no event later than twenty-one (21) calendar days after first observance of the condition. The Consultant will promptly investigate such conditions and, if they differ materially will recommend an equitable adjustment in the Agreement. If the Consultant determines that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Agreement is justified, the Consultant shall so notify the Director and Contractor through Director in writing, stating the reasons. Claims by the Contractor in opposition to such determination must be made within twenty-one (21) calendar days after the Consultant has given notice of the recommendation.

G. If the Contractor wishes to make Claim for an increase in the contract time, written notice as provided herein shall be given. The Contractor's Claim shall include an estimate of cost and/or probable effect of delay on progress of the Work in the case of a continuing delay only one Claim is necessary. If unusual weather conditions are the basis for a Claim for additional time, such Claim shall be documented by data substantiating weather conditions were abnormal for the period of time and could not have been reasonably anticipated, and weather conditions had an adverse effect on the scheduled construction.

H. The Contractor waives any claim for consequential damages, incidental damages, indirect or special damages, punitive damages, and claims for specific performance, unjust enrichment, and/or quantum meruit arising out of or relating to the agreement. This waiver is applicable, without limitation, to all consequential damages related to termination in accordance with Article 56. Nothing contained in this subpart (H) shall be deemed to preclude an aware of liquidated direct damages, when applicable, in accordance with the requirements of the contract documents.

ARTICLE 14 – RESOLUTION OF CLAIMS AND DISPUTES

A. The Consultant through the Director will review Claims and take one or more of the following preliminary actions within thirty (30) calendar days of receipt of a Claim:

- (1) Request additional supporting data from the claimant,
- (2) Submit a schedule to the Contractor indicating when the Consultant expects to take action,
- (3) Reject the Claim in whole or in part, stating reasons for rejection,
- (4) Recommend approval of the Claim or
- (5) Suggest a compromise.

The Director may also, but is not obligated to, notify the surety of the nature and amount of the Claim.

B. If a Claim has not been resolved, the Contractor shall, within fourteen (14) calendar days after the Consultant's preliminary response, take one or more of the following actions:

- (1) Submit additional supporting data requested,
- (2) Modify the initial Claim, or
- (3) Notify the Director that the initial Claim stands.

C. If a Claim has not been resolved after consideration of further evidence as presented by the Contractor, the Director's decision will be made within thirty (30) calendar days following the Contractor's response. During that 30-day period, the Director may request a supplemental recommendation from the Consultant, considering the Contractor's response. Any such decision shall be final, but subject to Administrative Review. Upon expiration of such time period, the Director will render to the Contractor the Consultant's written decision relative to the Claim, including any change in the Agreement. If there appears to be the possibility of a Contractor's default the Director may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

D. In order to prevent all disputes or disagreements between the parties aforesaid in relation to the performance hereof, on the part of this Contractor, it is hereby expressly agreed and understood that in case any controversy or difference of opinion shall arise between the parties aforesaid as to the quality or quantity or value of the Work, or material, the interpretation of plans, specifications and provisions of the Contract Documents, or any other matter connected with the Work, or the performance of the covenants and agreements herein contained, on the part of this Agreement, the decision of the Director shall be final and binding on all parties subject to Administrative Review.

E. Request for Administrative Review may be made by any party, in writing, to the other party within thirty (30) calendar days following the decision of the Director. The request for review shall include a statement of reasons of disagreement with the decision of the Director, as well as the statement of the requested relief or remedy. Within thirty (30) calendar days after the request for Administrative Review, the parties will select an Arbitrator to hear the dispute. A panel of arbitrators will be obtained from the Federal Mediation Conciliation Service, American Arbitration Association, or other recognized Dispute Resolution body. The parties will alternatively strike the panel of arbitrators until one arbitrator remains. The party requesting the Administrative Review will make the first strike. The parties may agree to terms of procedures of the arbitration before the neutral Arbitrator. If terms cannot be agreed, the applicable procedures of the American Arbitration Association will be followed.

F. The parties will share equally the expenses of arbitration, consisting primarily of the Arbitrator's fee and expenses, and the arrangements and fees for the presentation and location of the arbitration hearing, as well as any fees charged by the Dispute Resolution body. Either party may make, at its own

expense, a transcript or recording of the arbitration hearing. If the other party desires access to such transcript, it will pay one-half (1/2) of the expense incurred in preparing the transcript. The parties may be represented by legal counsel, and each party is responsible for its own legal expenses. The location of an arbitration hearing will be mutually agreed upon by the parties, if no agreement is possible, then arbitration shall be held in a conference room at the University Plaza Hotel and Convention Center in Springfield, Missouri.

G. The Arbitrator will issue his/her decision in writing, within thirty (30) calendar days after the close of the hearing, unless the parties agree otherwise. The parties may request to submit briefs following the hearing, which may extend the time period, as determined by the Arbitrator. The decision of the Arbitrator shall be final except as appeal is permitted pursuant to the agreed terms of procedures of the arbitration before the neutral Arbitrator or the applicable procedures of the American Arbitration Association if the parties cannot agree on terms of procedure of the arbitration.

ARTICLE 15 – DEBARMENT

A. The Owner will consent to the use of Subcontractors and award contracts to only responsible Contractors. Debarment is a discretionary action of a serious nature and imposed only in the public interest for the Owner's protection and not as a punitive measure.

B. The Owner will consider the Contractor's past performance with projects both for the University and with other Owners in determining if the Contractor is responsive. Included in this consideration will be if Contractor has:

- (1) provided false or misleading information as part of any qualification statement, bid or contract;
- (2) refused or failed to supply enough properly skilled workers, Superintendents, foremen or managers;
- (3) refused or failed to supply sufficient or proper materials;
- (4) failed to make payment to Subcontractors for materials or labor in accordance with the respective Agreements between the Contractor and the Subcontractors;
- (5) disregarded laws, ordinances, rules, or regulations or orders of a public authority having jurisdiction;
- (6) disregarded the authority of the Owner's Designated Representative or Consultant;
- (7) breached any warranty or representations made by the Contractor under or pursuant to the Contract Documents;
- (8) failed to furnish the Owner with assurances satisfactory to the Owner evidencing the Contractor's ability to complete the Work in compliance with all the requirements of the Contract Documents;
- (9) failed after commencement of the Work to proceed continuously with the construction and completion of the Work for more than ten (10) days, except as permitted under the Contract Documents;
- (10) failed to maintain a satisfactory rate of progress with the Work or comply with approved progress schedules;
- (11) violated in any substantial way any provisions of the Contract Documents; or
- (12) has been debarred from contracting by any other federal or state body.

C. Debarment shall be imposed for a specified time not to exceed five (5) years unless reasons for a longer period are stated in the notice of debarment.

D. The Owner may extend debarment for an additional specified period at any time before a debarment expires upon adequate evidence in addition to that which supported the original debarment in accordance with the procedure for debarment.

E. The Owner may reduce the period of debarment upon the Bidder's or Contractor's written request supported by adequate evidence:

- (1) that corrective action will be taken to assure that past performance issues will be prevented;
- (2) bona fide change in ownership or management of the Bidder or Contractor; or
- (3) elimination of other causes for which debarment was imposed.

F. The Owner shall begin debarment proceedings by the Debarment Official giving notice of intent to debar to the Contractor by certified mail, return receipt requested, stating:

- (1) the intent to debar for a specified period.
- (2) the cause for debarment with a summary of the information on which the findings of causes are based.
- (3) the debarment is effective immediately and the decision will become final within twenty-one (21) calendar days unless the Contractor submits a written response to the Debarment Official within that time opposing the debarment, including information raising a genuine dispute as to the facts on which it is based.

G. If a Contractor timely opposes debarment, the Debarment Official shall:

- (1) Schedule an informal hearing within fifteen (15) days, with written notice to the parties, at which the Owner and the Contractor may present evidence on issues raised by the notice of debarment and the response thereto;
- (2) Issue a written decision within fifteen (15) days of the hearing, either sustaining or overruling the debarment, and stating:
 - (a) a summary of the evidence presented;
 - (b) conclusions applying these conditions to the facts, serving this decision on the Contractor by certified mail, return receipt requested.

H. The Debarment Official's decision shall be final.

I. The Owner may continue in effect any Agreements with debarred persons which have not been fully performed at the time of debarment in accordance with their terms.

J. When a debarred Contractor is proposed as a Subcontractor for any subcontract subject to Owners approval, the Owner shall not approve such Subcontractor unless the Contractor states in writing the compelling reasons for such approval.

K. The Debarment Official shall maintain records of all persons debarred for the purpose of enforcing these conditions.

CONTRACTORS EXECUTION AND SUPERVISION

ARTICLE 16 – PREVAILING WAGE

A. Missouri's Prevailing Wage Law establishes a prevailing hourly wage rate and a public works contracting minimum wage, and whichever rate is applicable must be paid to workers on public works construction projects in Missouri, such as bridges, roads, and government buildings, for which the Agreement awarded is in the amount of seventy five thousand dollars or more. The prevailing hourly wage rates and public works contracting minimum wage rates differ by county and for different types of work.

B. The Prevailing Wage Law applies to all public works projects constructed by or on behalf of state and local public bodies for Agreements in the amount of seventy five thousand dollars or more. Not less than the prevailing hourly rate of wages or public works contracting minimum wage, whichever is applicable, shall be paid to all workers performing work under such Agreements. Section 290.250, RSMo. The following provisions apply only to construction of public works for Agreements of seventy five thousand dollars or more.

- (1) The Contractor and each Subcontractor engaged in construction of public works shall keep full and accurate records clearly indicating the names, occupations and crafts of every worker employed by them in connection with the public work together with an accurate record of the number of hours worked by each worker and the actual wages paid therefore. The payroll records required to be so kept shall be open to inspection by any appointed representative of the contracting public body or of the department at any reasonable time and as often as may be necessary and such records shall not be destroyed or removed from the state for the period of one year following the completion of the public work in connection with which the records are made. Contractors shall submit certified copies of their payrolls to the contracting public body on a monthly basis.
- (2) For any construction of public works, each Contractor and Subcontractor shall file with the contracting public body upon completion of the public work and prior to final payment the enclosed wage rate affidavit included in Appendix A stating that they have fully complied with the provisions and requirements of this chapter and as set forth in the Department of Labor and Industrial Relations Prevailing Wage Section 290.290, RSMo., and no public body shall be authorized to make final payment until such affidavit is filed therewith in proper form and order.
- (3) Each Contractor and Subcontractor engaged in construction of public works for Agreements in the amount of two hundred fifty thousand dollars or more shall have its name, acceptable abbreviation or recognizable logo and the name of the city and state of the mailing address of the principal office of the company, on each motor vehicle and motorized self-propelled piece of equipment which is used in connection with such public works project during the time the Contractor or Subcontractor is engaged on such project. The sign shall be legible from a distance of twenty feet but the size of the lettering need not be larger than two inches. In cases where equipment is leased or where affixing a legible sign to the equipment is impractical, the Contractor may place a temporary stationary sign, with the information required pursuant to this subsection, at the main entrance of the construction project in place of affixing the required information on the equipment so long as such sign is not in violation of any state or federal statute, rule or regulation. Motor vehicles which are required to have similar information affixed thereto pursuant to requirements of a regulatory agency of the state or federal government are exempt from the provisions of this subsection.

C. Per Section 290.265, RSMo., a clearly legible statement of all prevailing hourly wage rates to be paid to all workers employed in order to execute the Agreement and employed on the construction of the public works is kept posted in a prominent and easily accessible place at the site thereof by each Contractor and Subcontractor engaged in the public works project under the provisions of this law and such notice shall remain posted during the full time that any worker shall be employed on the public works.

D. Per Section 290.250, RSMo., the Contractor shall forfeit as a penalty to the public body on whose behalf the contract is made or awarded one hundred dollars for each worker employed, for each calendar day, or portion thereof such worker is paid less than the specified wage rates for any work done under said Agreement, by the Contractor or by any Subcontractor under the Contractor.

E. The Owner, and its agents and officers, shall take cognizance of all complaints of all violations of the provisions of Sections 290.210 to 290.340 RSMo. committed in the course of the execution of the contract, and, when making payments to the contractor becoming due under the contract, shall withhold and retain therefrom all sums and amounts due and owing as a result of any violation of sections 290.210 to 290.340 RSMo.

ARTICLE 17 – MBE/WBE/SDVE REQUIREMENTS

For all agreements, the following provisions shall apply:

A. The Contractor is bound to subcontracting not less than the percent indicated in the awarded contract to MBE/WBE/SDVE(s).

B. If the Contractor fails to meet or maintain stated percent, he/she must satisfactorily explain to the Director why the requirement cannot be achieved and why meeting the requirement was beyond the Contractor's control.

C. If the Director finds the Contractor's explanation unsatisfactory, the Director will notify the Commissioner. The Commissioner may take any appropriate action including, but not limited to:

- (1) Declaring the Contractor ineligible to participate in any state contracts administered through the Office of Administration for a period not to exceed six (6) months; and
- (2) Directing that the Contractor be declared in breach of the Agreement.

D. If a MBE/WBE/SDVE is replaced during the course of the Agreement, the Contractor shall make a good faith effort to replace it with another MBE/WBE/SDVE. All substitutions shall be approved by the Director.

E. The Contractor shall provide the Director with regular reports on its progress in meeting its MBE/WBE/SDVE obligations. As a minimum, the dollar-value of work completed by each MBE/WBE/SDVE Subcontractor during the preceding month and as a cumulative total shall be reported with each monthly application for payment. A final report shall include the total dollar-value of work completed by each minority Subcontractor during the total Agreement.

ARTICLE 18 – NONDISCRIMINATION IN EMPLOYMENT

A. The Contractor and their Subcontractors will not discriminate based on affected group status unless with respect to sex, age, or disability status such restrictions relate to the bona fide occupational qualifications. Specifically, the Contractor and their Subcontractors shall not discriminate:

- (1) Against recipients of service on the basis of race, color, religion, national origin, sex, disability, or age.
- (2) Against any employee or applicant for employment on the basis of race, color, religion, national origin, sex, or otherwise qualified disability status.
- (3) Against any applicant for employment or employee on the basis of age, where such applicant or employee is between ages 40 and 70 and where such Contractor employs at least 20 persons.
- (4) Against any applicant for employment or employee on the basis of that person's status as a disabled or Vietnam-era veteran.

B. The Contractor and Subcontractors will take affirmative action to insure applicants are employed and employees are treated during employment without regard to the above considerations. Such action shall include, but not be limited to, the following: employment, upgrading, demotion and transfer; recruitment advertising; and selection for training, including apprenticeship. The Contractor and Subcontractor will give written notice of their commitments under this clause to any labor union with which they have bargaining or other agreements.

C. Facilities provided for employees will be provided in such a manner that segregation on the basis of race, color, religion, or natural origin cannot result.

D. The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, religion, color, age, sex or national origin.

E. The Contractor will send to each labor union or representative of workers with which he or she has a collective bargaining agreement or other contract or understanding, a notice advising that the labor union or workers' representative of the Contractor's commitments under Section 202 of the Executive Order No. 11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

F. The Contractor will comply with all provisions of Executive Order No. 11246 of September 24, 1965, and of rules, regulations and relevant orders of the Secretary of Labor, and shall also comply with the Missouri Fair Employment and Public Accommodation Practices Act, Chapter 213 RSMo., any applicable provisions of the Americans with Disabilities Act of 1990, Titles VI and VII of the Civil Rights Act of 1964, all incorporated herein by reference, and will hold harmless MSU from any violation or claimed violation of law, ordinance or regulation arising from this Agreement.

G. The Contractor will furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, and by the rules, regulations and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his/her books, records, and accounts by an appropriate agency of the Federal government and by the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations and orders.

H. Each prime Contractor and Subcontractor shall file annually, on or before the 31st day of March, complete and accurate reports on Standard Form 100 (EEO-1) promulgated jointly by the Office of Federal Contract Compliance Programs, the Equal Employment Opportunity Commission and Plans for Progress or such form as may hereafter be promulgated in its place if such prime Contractor or Subcontractor (i) is not exempt from the provisions of the regulations in accordance with 60-1.5; (ii) has 50 or more employees; (iii) is a prime Contractor or first tier Subcontractor; and (iv) has a contract, subcontract or purchase order amounting to \$50,000 or more or serves as a depository of Government funds in any amount, or is a financial institution which is an issuing and paying agent for U.S. savings bonds and savings notes: Provided, that any Subcontractor below the first tier which performs construction work at the site of construction shall be required to file such a report if it meets requirements of paragraphs (i), (ii), and (iv) of this section.

I. In the event of the Contractor's noncompliance with the Equal Opportunity conditions of this contract or with any such rules, regulations or orders, this contract may be canceled, terminated or suspended in whole or in part, and the Contractor may be declared ineligible for further government contracts, or federal assisted contracts, in accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in said Executive Order, or by rule, regulation or Order of the Secretary of Labor, or as otherwise provided by law.

J. The Contractor will include this paragraph and the above paragraphs in this Article in every subcontract or purchase order unless exempted by rules, regulations or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246 of September 24, 1965, so that provisions will be binding upon each Subcontractor or vendor. The Contractor will take such action with respect to any Subcontractor or vendor as the appropriate agency of the Federal Government may direct as a means of enforcing such provisions, including sanctions for non-compliance; provided, however, that in

the event the Contractor becomes involved in, or is threatened with, litigation with a Subcontractor or vendor as a result of such direction by the appropriate agency of the Federal Government, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

K. Exemptions to the requirements of the above Equal Opportunity conditions are contracts and subcontracts not exceeding \$10,000.00, and contract and subcontracts with regard to work performed outside the United States by employees who were not recruited in the United States.

L. The Contractor and their Subcontractors shall develop, implement, maintain and submit in writing to the Director an affirmative action program if at least fifty (50) persons in the aggregate are to be employed under this Agreement. If less than fifty (50) persons in the aggregate are to be employed under this contract, the Contractor shall submit, in lieu of the written affirmative action program, a properly executed Certificate for Affirmative Action in the form as included in the contract specifications. For the purpose of this section, an "affirmative action program" means positive action to influence all employment practices (including, but not limited to, recruiting, hiring, promotion and training) in providing equal employment opportunity regardless of race, color, sex, national origin, religion, age (where the person affected is between 40 and 70), disabled and Vietnam-era veteran status, and handicapped otherwise qualified status. Such "affirmative action program" shall include:

- (1) A written policy statement committing the total organization to affirmative action and assigning management responsibilities and procedures for evaluation and dissemination;
- (2) The identification of a person designated to handle affirmative action;
- (3) The establishment of non-discriminatory selection standards, objective measures to analyze recruitment, an upward mobility system, a wage and salary structure, and standards applicable to lay-off, recall, discharge, demotion and discipline;
- (4) The exclusion of discrimination from all collective bargaining agreements; and
- (5) Performance of an internal audit of the reporting system to monitor execution and to provide for future planning.

M. The required Certificate of Affirmative Action shall be submitted with bid. In the enforcement of this non-discrimination clause, the Owner may use any reasonable procedures available, including, but not limited to: requests, reports, site visits and inspection of relevant documents to the Contractors and Subcontractors.

N. In the event of the Contractor's or a Subcontractor's noncompliance with any provisions of this Article, the Director may cancel this Agreement in whole or in part or require the Contractor to terminate the contract with their Subcontractor.

O. The Contractor and their Subcontractors shall provide the Director accurate information for quarterly and final reports of the number and percentage of minority workmen, classified by trade, and a list of all minority Subcontractors or, in the case of projects equal to or greater than one hundred thousand dollars (\$100,000.00), MBE/WBE(s) involved on this construction project. The Contractor shall be responsible for obtaining and reporting this information with respect to their firm and for all Subcontractors. The reports shall include:

- (1) The total number of individual minority employees, excluding females, working on the construction project, classified by trade, that were employed during the three months preceding and including the last regular working day of the month of March, June, September or December, as applicable. The final report shall reflect all minority employment, excluding females, occurring since the last quarterly report or the overall minority employment if there was no prior report due.
- (2) The percentage of minority workmen classified by trade as reported in (1).
- (3) A list of all minority Subcontractors including the trade classification and mailing address

of each firm working on the project.

- (4) An estimate of the dollar-value of work completed by each minority Subcontractor during the quarterly reporting period and as a cumulative total through the reporting period. The final report shall include an estimate of the dollar-value of work completed by each minority Subcontractor during the last quarterly report or the overall dollar-value for the contract if there was no prior report due.
- (5) The total number of female employees working on the project, classified by trade, that were employed during the three months preceding and including the last regular working day of the month of March, June, September or December, as applicable. The final report shall reflect all female employment occurring since the last quarterly report of the overall female employment if there was no prior report due.

P. The quarterly reports shall be submitted with the corresponding April, July, October or January application for payment throughout the project until completed. The final report shall be due upon submission of the final payment request.

Q. Missouri State University abides by the requirements of 41 CFR 60-1.4(a), 60-300.5(a) and 60-741.5(a). These regulations prohibit discrimination against qualified individuals based on their status as protected veterans or individuals with disabilities, and prohibit discrimination against all individuals based on their race, color, religion, sex, or national origin. Moreover, these regulations require that covered prime contractors and subcontractors take affirmative action to employ and advance in employment without regard to race, color, religion, sex, national origin, protected veteran status or disability. The Contractor is responsible for compliance of the above requirements. When requested, the Contractor shall provide documentation of good faith efforts and the necessary proof of compliance.

ARTICLE 19 – PAYMENT AND PERFORMANCE BOND

A. The Contractor shall execute the Performance and Payment Bond as prepared by the Owner and attached in Appendix A, or another form similar in form and content, in an amount equal to one hundred percent (100%) of the Agreement sum as security for the faithful performance of this Agreement and as security for the payment of all persons performing labor on the project under this Agreement and furnishing materials in connection with this Agreement. This bond shall be in effect through the duration of the one-year warranty period.

ARTICLE 20 – CONTRACTOR'S INSURANCE

A. The successful Contractor shall procure and maintain for the duration of the Agreement a policy or policies of insurance for the protection of both the Contractor and the Owner and their respective officials. The Contractor shall not commence Work under this Agreement until the Contractor has obtained and submitted to the Owner a "Certificate of Insurance" for all insurance required under this Article and such insurance has been approved by the Owner; nor shall the Contractor allow any Subcontractor to commence work on any subcontract until all similar insurance required of the Subcontractor has been obtained and approved. Please carefully review the requirements outlined below.

It is highly recommended that you confer with your insurance broker/agent or other insurance company representative, prior to submitting your bid, to determine availability and applicable cost, if any, of certificates, endorsement, coverages, and limits required.

B. WORKERS' COMPENSATION INSURANCE – Workers' Compensation Insurance for all of their employees doing work on the project, and, in case any work is sublet, Contractor shall require any and/or all Subcontractor(s) similarly to provide Workers' Compensation Insurance for all their employees unless such employees are covered by the protection afforded by Contractor. In case any class of employees engaged in hazardous work under this Agreement at the site of the Project is not covered under the Workers' Compensation Statute, the Contractor shall provide and shall cause each Subcontractor to provide Employer's Liability Insurance covering these employees. Contractors shall

provide coverage under the "Occupational Disease Act" of the State of Missouri, in addition to the above requirements, if the operations of the Contractor or any Subcontractor are applicable thereunder. Workers' Compensation Insurance shall comply in all respects with the requirements and limits of the Statutes of the State of Missouri.

C. COMMERCIAL GENERAL LIABILITY INSURANCE – The Contractor shall obtain one or more occurrence-based policies of Commercial General Liability Insurance which provide coverage for the Work and shall protect the Contractor, the Owner, and any Subcontractor performing work covered by this Agreement from claims for damages for personal injury, bodily injury, including wrongful death, and from claims for property damage which may arise from the operations under the Agreement.

- (1) Commercial General Liability Insurance, including coverage for Premises, Operations, Products and Completed Operations, Broad Form General Liability, and Contractual Liability, shall apply to Bodily Injury and Property Damage on an "Occurrence Form Basis" with minimum limits of **\$1,000,000** each bodily injury or property damage occurrence, and **\$2,000,000** general aggregate with a per project endorsement.

D. COMMERCIAL AUTOMOBILE LIABILITY INSURANCE – The Contractor shall obtain one or more occurrence-based policies of auto liability insurance, which provide coverage for all vehicles that will be used on University property in conjunction with the Work whether they are owned, non-owned or hired vehicles of every type and description.

- (1) Automobile Liability Insurance covering Bodily Injury and Property Damage on an "Occurrence Form Basis" with minimum limits of **\$1,000,000** combined single limit.

E. UMBRELLA/EXCESS LIABILITY – Contractor shall provide an Umbrella Policy of Insurance to protect the University, the Board of Governors for Missouri State University, its members, agents, and employees from the performance of this Agreement with a minimum limit of coverage of **\$5,000,000** in excess over the CGL policy. The University shall be named as additional insured on the policy. The policy shall provide for coverage of occurrences from which the University, its officers and employees are not immune under the doctrines of sovereign, official and governmental immunity.

F. ADDITIONAL INSUREDS – Each policy of commercial liability insurance shall name Missouri State University, the Board of Governors of Missouri State University, its members, agents and employees as additional insureds. The insurance afforded by the Contractor shall be primary insurance.

G. ALL RISK BUILDER'S RISK OR INSTALLATION FLOATER INSURANCE – The Contractor shall purchase and maintain, in a company or companies lawfully authorized to do business in the State of Missouri, as an admitted carrier, Builder's Risk or Installation Floater Insurance on the entire Work. Such insurance shall be written on a completed value form for the entire Work. The insurance shall apply on a replacement cost basis.

- (1) The insurance as required herein shall name as insureds the Owner, Contractor and all Subcontractors of any tier. The insurance policy shall contain a provision that the insurance will not be canceled, allowed to expire or materially changed until at least thirty (30) days prior written notice has been given to Owner.
- (2) The insurance as required herein shall cover the entire Work, including reasonable compensation for Consultant's services and expenses made necessary by an insured loss. Insured property shall include portions of the Work located away from the site but indebted for use at the site, and shall also cover portions of the Work in transit, including ocean transit. The policy shall include as insured property scaffolding, false work, and temporary buildings located at the site. The policy shall cover the cost of removing debris, including demolition as may be made legally necessary by the operation of any law, ordinance or regulation. The policy shall also contain an endorsement to include permission for partial occupancy.
- (3) The insurance required herein shall be on an all risk form and shall be written to cover all risks of physical loss or damage to the insured party and shall insure at least against the

perils of fire and extended coverage, theft, vandalism, malicious mischief, collapse, lightening, frost, water damage, windstorm and freezing.

- (4) If there are any deductibles applicable to the insurance required herein, Contractor shall pay any part of any loss not covered because of the operation of such deductibles.
- (5) The insurance as required herein shall be maintained in effect until the earliest of the following dates:
 - (a) The date which all persons and organizations who are insured under the policy agree in writing that it shall be terminated;
 - (b) The date on which final payment of this Contract has been made by Owner to Contractor; or
 - (c) The date on which the insurable interests in the property of all insureds other than the Owner have ceased.
- (6) The Owner and Contractor waive all rights against (1) each other and any of their subcontracts of any tier, suppliers, agents and employees, each of the other, (2) the Consultant and Consultant's consultants, and (3) separate Contractors described in the Separate Contracts Article, if any, and any of their Subcontractors of any tier, suppliers, agents and employees, for damages caused by fire or other perils to the extent covered by property insurance obtained pursuant to this Article or other insurance applicable to the Work, except such rights as they have to proceeds of such insurance. The Owner or Contractor, as appropriate, shall require of the Consultant, Consultant's consultants, separate Contractors described in the Separate Contracts Article, if any, and the Subcontractors of any tier, suppliers, agents and employees of any of them, by appropriate agreements, written where legally required for validity, similar waivers each in favor of other parties enumerated herein. The policies shall provide such waivers of subrogation by endorsement or otherwise. A waiver of subrogation shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the insurance premium directly or indirectly, was at fault or was negligent in causing the loss and whether or not the person or entity had an interest in the property damaged.
- (7) A loss insured under Contractor's property insurance shall be adjusted by the Owner in good faith and made payable to the Owner for the insureds, subject to the requirements of the Contract Documents. At its option, Owner may instead allow the proceeds to be placed in escrow or with an independent adjuster. The Contractor shall pay Subcontractors of any tier their just shares of insurance proceeds received by the Contractor, any appropriate agreements, written where legally required for validity, shall require Subcontractors of any tier to make payments to their Sub-subcontracts in similar manner.

H. INSURANCE COVERING SPECIAL HAZARDS – If applicable, the Commercial General Liability Insurance policy or policies of the Contractor shall provide coverage for special hazards such as, but not limited to, operation of material hoists, blasting or other use of explosives, earthquake, flood, pollution, PCB transformers and damage to underground property.

I. SATISFACTORY COVERAGE – Such insurance coverage shall be written by a company authorized to do business in the State of Missouri and the form and content of the policies and the companies issuing the same shall be subject to the approval of the Owner. In the event that the form of any policy or certificates or the amount of the insurance or the companies writing same are not satisfactory to the Owner, the Contractor shall secure other policies or certificates in form and amount and with companies satisfactory to the Owner. The Contractor shall not cause any policies to be cancelled or permit them to lapse and all insurance policies shall include a clause to the effect that the policy shall not be cancelled or changed until thirty (30) days after the Owner has received written notice.

- (1) It is understood and agreed that the insurance required by the provisions of this Article is required in the public interest and that the Owner does not assume any liability for acts of the Contractor, any Subcontractor or their employees in the performance of the Agreement.
- (2) If Owner is damaged by delay or failure of Contractor to maintain insurance as required in this Article, then Contractor shall bear all reasonable costs properly attributable to that delay or failure.

J. PROOF OF INSURANCE COVERAGE – Certificates of Insurance shall be provided, authenticated by the proper officer of the insurer, evidencing in particular those insured, the extent of the insurance, the exclusions and endorsements, the location and operations to which the insurance applies, the effective date and expiration date and the notice of cancellation clause mentioned herein before. Owner shall have a right to see the entire policy upon request.

K. Notwithstanding any other provision of these Contract Documents to the contrary, no insurance procured by Contractor shall be construed to constitute a waiver of any sovereign immunity as set forth in § 537.600 *et seq.*, RSMo., or any other governmental or official immunity, nor provide coverage for any liability or suit for damages which is barred under said doctrines of sovereign, governmental, or official immunity available to Owner, its officers or employees, nor constitute waiver of any available defense; and neither shall such insurance provide coverage for any sums other than those which Owner, its officers or employees, may be obligated to pay as damages. The Contractor shall cause all policies of insurance procured pursuant to this Article to be endorsed in accord with this paragraph. Contractor shall further require the upper limits of such policies to be adjusted on an annual basis to be at least equal to the limits of liability set forth in §§ 537.610.2 and 537.610.5, RSMo., as may be amended from time to time.

ARTICLE 21 – INDEMNIFICATION

A. To the extent that the following does not void or make voidable any insurance coverage or waive any monetary limits, sovereign, governmental, or official immunity or any other rights, immunities and protections provided by the United States or the State of Missouri, Contractor agrees to defend, indemnify and hold harmless to the fullest extent possible the Owner, its agents, servants and employees, representatives (hereinafter “Owner”) from and against any and all liability for claims, damages, punitive damages, penalties and civil fines unless expressly prohibited by law, losses and expenses, including, but not limited to, attorneys’ fees, arising out of or in any manner connected with this Agreement, to the extent the foregoing is caused or claimed to be caused in whole or in part by the act, omission, error, professional error, mistake, negligence or willful act of Contractor, any Subcontractor of the Contractor, or anyone directly or indirectly employed by them or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss, or expense is caused in part by the negligent acts or omissions or other fault of a party indemnified hereunder. The Contractor’s obligations hereunder are in addition to and shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity that the Owner may possess. The Contractor agrees to investigate, handle, respond to, and provide defense for and defend against, any such liability, claims, and demands at the sole expense of the Contractor, or at the option of Owner agrees to pay to or reimburse Owner for the defense costs incurred by Owner in connection with any such liability claims, or demands. The defense and indemnity required herein shall be a binding obligation upon Contractor whether or not Owner has made such demand. Even if a defense is successful to a claim or demand for which Contractor is obligated to indemnify the Owner under this Paragraph, Contractor shall remain liable for all costs of defense.

B. The indemnity obligations of Contractor under this Article shall survive termination of this Agreement or final payment thereunder. In the event of any claim or demand made against any party which is entitled to be indemnified hereunder, the Owner may in its sole discretion reserve, return or apply any monies due or to become due the Contractor under the Agreement for the purpose of resolving such claims; provided, however, that the Owner may release such funds if the Contractor provides the Owner with reasonable assurance of protection of the Owner’s interests. The Owner shall in its sole discretion determine if such assurances are reasonable. Owner reserves the right to control the defense and settlement of any claim, action or proceeding for which Contractor has an obligation to indemnify Owner against under this Article.

C. In claims against any person or entity indemnified under this Article by an employee of the Contractor, a Subcontractor of any tier, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, the indemnification obligation under this Article shall not be limited by a limitation on amount or type of damages, compensation or benefits payable by or for the Contractor or a Subcontractor of any tier under workers' compensation acts, disability benefit acts or other employee benefit acts.

ARTICLE 22 – ROYALTIES AND PATENTS

A. The Contractor shall pay all royalties and license fees, shall defend all suits or claims for infringement of any patent rights and shall save the Owner harmless from loss on account thereof.

ARTICLE 23 – TAXES

A. The Owner is exempt from payment of State of Missouri, County, and City sales or use taxes on the purchase of all building materials and equipment made on behalf of the University. Therefore, the Bidder shall not include sales or use taxes in the proposal.

B. The Owner shall furnish the Contractor an exemption certificate authorizing purchases of tangible personal property and materials to be incorporated into or consumed in the construction of the Project. Such certificate is renewable for a given project at the option of the Owner only for the purpose of revising the certificate expiration date as necessary to complete the Project.

C. The Contractor shall furnish the exemption certificate to all Subcontractors, and any Contractor purchasing materials shall present such certificate to all material suppliers as authorization to purchase, on behalf of the Owner, all tangible personal property and materials to be incorporated into or consumed in the construction of this Project and no other on a tax-exempt basis. Such suppliers shall execute to the purchasing Contractor invoices bearing the name of the exempt entity and the Project identification number. Nothing in this Article shall be deemed to exempt the purchase of any construction machinery, equipment or tools used in constructing, repairing or remodeling facilities for the Owner. All invoices for all personal property and materials purchased under a Project exemption certificate shall be retained by the purchasing Contractor for a period of five years and may be subject to audit by the Missouri Director of Revenue as provided by Missouri law.

D. Any excess resalable tangible personal property or materials which were purchased for the project by a Contractor under a Project exemption certificate but were not incorporated into or consumed in the construction of the Project shall be returned to the supplier for credit. If unreturned, the appropriate sales or use tax on such excess property or materials shall be reported by the Contractor on a return and paid by such Contractor not later than the due date of the Contractor's Missouri sales or use tax return following the month in which it was determined that the materials were not to be used in the Project.

ARTICLE 24 – SURVEYS, PERMITS, AND REGULATIONS

A. The Owner shall furnish all surveys unless otherwise specified. The Contractor shall obtain and pay for all permits, licenses, certificates, inspections and other legal fees required by all applicable municipal ordinances and state and federal laws. Easements for permanent installations shall be secured and paid for by the Owner, unless otherwise specified.

B. All Contractors performing work on the Project shall be licensed in the City of Springfield, Missouri and all personnel involved in the Project shall be certified in their trade in accordance with the City of Springfield, Missouri requirements.

C. The Contractor shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the Work as drawn and specified. If the Contractor observes that the drawings and specifications are at variance therewith, he or she shall promptly notify the Owner in writing, and any necessary changes shall be adjusted as provided in the Contract Documents for changes in the Work. If the Contractor performs any Work knowing it to be contrary to such laws, ordinances, rules and regulations, and without such notice to the Owner, Contractor shall bear all costs arising there from.

ARTICLE 25 – SUPERINTENDENT

A. The Contractor shall keep on the Project during its progress a competent Superintendent satisfactory to the Owner. The Contractor shall not change the Superintendent during the course of the Project without written approval from Owner.

B. The Superintendent shall represent the Contractor. The Superintendent shall give efficient supervision to the Project, using the Superintendent's best skill and attention. The Superintendent shall carefully study and compare all drawings, specifications and other instruction and shall, at once, report to the Owner any error, inconsistency or omission which the Superintendent discovers.

ARTICLE 26 – MEASUREMENTS

A. Before ordering any material or doing any Work the Contractor or Subcontractors shall verify all measurements at the Project and shall be responsible for the correctness of same. No extra charge shall be allowed on account of the difference between actual dimensions and the dimensions indicated on the drawings; any differences that may be found shall be reported to the Owner's appointed representative for consideration before proceeding with the Work.

ARTICLE 27 – MATERIALS AND WORKMANSHIP

A. Unless otherwise specified, all materials shall be new and both workmanship and materials shall be of good quality. If required by the Owner, satisfactory evidence shall be furnished as to the kind and quality of the materials, and workmanship.

B. All materials and workmanship used in the Work shall be subject to the inspection of the Owner, and the decision of its representatives as to what conforms to the specifications shall be final and conclusive on all parties, and any Work which they shall decide to be defective shall be removed, rebuilt or made good, the cost of such correction to be borne by the Contractor. All condemned materials shall be immediately removed from the vicinity of the Work.

C. Failure or neglect on the part of the Owner to condemn or reject bad or inferior materials or workmanship shall not be construed to imply an acceptance of any Work. The Work herein specified to be done is not to be considered as finally accepted until it is so stated in writing by the Owner.

ARTICLE 28 – MATERIALS, EQUIPMENT, AND LABOR

A. Unless otherwise stipulated, the Contractor shall provide and pay for all materials, labor, water, tools, equipment, light, power, transportation services, taxes, insurance and use taxes and other facilities necessary for the execution and completion of the Work. See the Article on Taxes for an explanation of the taxes to be included.

ARTICLE 29 – UNIVERSITY REGULATIONS

A. The Contractor shall be aware of the following rules and recommendations regarding Contractor's employees at Missouri State University:

- (1) No intoxicating beverages shall be carried or consumed on University property. No narcotics shall be carried or used on University property.
- (2) No firearms shall be allowed on University property.
- (3) The use of vulgar or obscene language on University property is prohibited.
- (4) Smoking or use of tobacco products (defined as smoking via cigarettes, smokeless tobacco, cigars, pipes, or the use of devices or products that may be used to smoke or mimic smoking including bongos, hookahs, vaporizers, e-cigarettes, etc.) is prohibited on University property. Refer to the Tobacco Use/Smoking Policy at www.missouristate.edu/tobacco for more information and for designated smoking areas around the perimeter of campus.

(5) The Contractor's storage and work areas shall be tightly secured during non-working hours.

(6) The University will not be responsible for the Contractor's tools, equipment, or materials.

(7) The use of campus waste receptacles and dumpsters is prohibited. In case of dispute, the Owner may cause the removal of any rubbish and charge the cost to the Contractor(s).

(8) The Contractor shall not load or permit any part of a structure to be loaded with a weight that will endanger its safety.

(9) The Contractor shall, at all times, enforce strict discipline and good order among their employees, and shall not employ on the Work any unfit person or anyone not skilled in the Work assigned to them.

(10) All areas within the limits of the construction site shall be maintained in a clean and orderly manner.

ARTICLE 30 – KEY POLICY

A. Keys shall be requested through Planning, Design and Construction. The Contractor shall provide Planning, Design and Construction advance notice of the need for access to a space and allow at least 72 hours for processing. The Contractor shall provide the name and contact information of the person authorized to pick up the key(s), the length of time the key(s) will be needed, and the specific location(s) where access is necessary.

B. The Contractor shall be financially responsible for the cost of any lost or stolen keys in accordance with University policies and procedures.

C. Final payment will not be made until it is verified that all keys checked out to the Contractor for the Project have been returned.

ARTICLE 31 – CONTRACTOR PARKING

A. Parking in or on campus parking lots requires a parking permit. These permits will be provided to the Contractor at no cost. Application for the required parking permits shall be by use of the Construction Parking Permit Application form provided in Appendix A. Failure to display a proper parking permit may lead to the issuance of a parking ticket. These tickets will be the Contractor's responsibility to pay and shall be paid prior to the issuance of the final payment due on the Project.

B. Parking along the street, lawn, entrances to facilities, bike paths, or sidewalks is prohibited unless the Contractor is delivering materials and no other option exists. If a vehicle space is not available in the immediate area of where material is being delivered, the Contractor may park the vehicle in an area that is deemed safe to unload. Once the vehicle has been unloaded, it must be immediately moved to valid parking space. Bicycles must be parked in designated bike racks and motorcycles/scooters must be parked in designated parking lot with an authorized parking pass.

ARTICE 32 – PROJECT SITE MAINTENANCE

A. The Contractor shall confine their apparatus, the storage of materials, and the operations of their workmen, to limits indicated by law, ordinance, permits or direction of the Owner's appointed representative and shall not unreasonably encumber the premises with their material.

B. The Contractor shall enforce the Owner's instructions regarding signs, advertisements, and smoking.

C. The Contractor shall at all times keep the premises free from accumulations of waste material or rubbish caused by the Contractor's employees or Work, and at the completion of the Work they shall

remove all rubbish from and about the building and all tools, scaffolding and surplus materials and shall leave the Work "broom clean" or its equivalent, unless more exactly specified. Rubbish shall be removed in an approved manner. Each Contractor is responsible for their waste removal.

D. It is the responsibility of the Contractor to maintain the construction area in a neat and orderly appearance. No grass or ground cover shall be allowed to grow in excess of 12". Should the Contractor fail to maintain the construction area in accordance with the requirements, the Owner may cause the maintenance of the area to occur and charge the cost to the Contractor(s).

ARTICLE 33 – PROTECTION OF WORK AND PROPERTY

A. The Contractor shall continuously maintain adequate protection for all the Work from damage and shall protect the Owner's property from injury or loss arising in connection with this Agreement. The Contractor shall make good any such damage, injury or loss.

B. The Contractor shall take all necessary precautions for the safety of employees on the Work, and shall comply with all applicable provisions of Federal, State, and Municipal safety laws and building codes to prevent accidents or injury to persons on, about or adjacent to the premises where the Work is being performed. The Contractor shall erect and properly maintain at all times, as required by the conditions and progress of the Work, all necessary safeguards for the protection of workmen and the public and shall post danger signs warning against the hazards created by such features of construction as protruding nails, hod hoists, well holes, elevator hatchways, scaffolding, window openings, stairways and falling materials; and whose duty shall be the prevention of accidents.

ARTICLE 34 – CUTTING, PATCHING, AND DIGGING

A. The Contractor shall do all cutting, fitting or patching that may be required to make its several parts come together properly and for it to receive or be received by Work or other Contractors shown upon, or reasonably implied by, the Contract Documents for the completed structure, and he or she shall make good after them as the Director may direct.

B. Any cost caused by defective Work shall be borne by the Contractor responsible therefor.

C. The Contractor shall not endanger any Work by cutting, digging or otherwise, and shall not cut or alter the Work of any other Contractor except with the written consent of the Owner's appointed representative.

ARTICLE 35 – UTILITIES

A. The Contractor shall take every precaution to protect existing utilities on the campus. The Contractor is responsible for contacting Missouri One Call to initiate a utility locate on campus. A minimum of 3 working days' notice must be given and a utility locate conducted before digging on campus can occur.

B. The Contractor shall not interrupt any utility service to the university without prior written approval. Should the project dictate the need for temporary utility interruption, the Contractor shall complete the Request for Utility Interruption form as attached following the General Conditions in Appendix A. The general Contractor or prime Contractor shall fill out this form in order to request a utility interruption. Once it is filled out, the request shall be sent to Planning, Design and Construction so arrangements can be made for the interruption of services. A minimum of 5 working days must be given prior to the need for the request.

C. Depending upon the extent or complexity of the request, additional time may be needed to fulfill the request. The Contractor shall take this into account when making the request and shall allow ample time for the Work to be completed.

ARTICLE 36 – INSPECTION OF WORK

A. Requests for Owner to inspect and approve Work shall be made in writing by use of the

attached Request for Inspection form following the General Conditions in Appendix A. The general Contractor or prime Contractor shall fill out this form in order to request an inspection. This form shall be used for inspections such as general, rough-in, or final inspections. Once it is filled out, the request shall be sent to Planning, Design and Construction in order to schedule an inspection. By requesting this inspection, the Contractor is certifying that the Project is ready for inspection. If at the time of inspection it is found that the Work is not ready for inspection, the Owner may charge the Contractor for all expenses related to the inspection and subsequent inspections. A minimum of 5 working days' notice must be given prior to the need for the request.

B. Owner may also inspect at its discretion, with or without notice, at any time during the course of the Project.

C. If any Work is covered up without approval or consent of the Owner, it must, if requested by the Owner, be uncovered at the expense of the Contractor. Should it be considered necessary or advisable by the Owner any time before final acceptance of the entire Work to make an examination of the Work already completed, by removing or tearing out same, the Contractor shall, on request, promptly furnish all necessary facilities, labor, and material. If such Work is found to be defective in any material respect, due to fault of the Contractor or their Subcontractor, Contractor shall pay for all the expenses of such examination and of satisfactory reconstruction. If, however, such work is found to meet the requirements of the Agreement, the actual cost of labor and material necessarily involved in the examination and replacement plus 10 percent shall be allowed the Contractor.

D. All materials and workmanship (if not otherwise designated by the specifications) shall be subject to inspection, examination and test by the Owner at any and all times during manufacture or construction and at any and all places where such manufacture or construction are carried on. The Owner shall have the right to reject defective material and workmanship or require its correction. Rejected workmanship shall be satisfactorily corrected. Rejected material shall be promptly segregated and removed from the Project, and satisfactorily replaced with proper material without charge therefor. If the Contractor fails to proceed at once with the correction of rejected defective materials or workmanship, the Owner may by agreement or otherwise have the defects remedied or rejected materials removed from the site and charge the cost of the same against any monies which may be due the Contractor without prejudice to any other rights or remedies of the Owner on the premises.

E. In response to request by interested citizens for legitimate reasons, as determined by Owner, the Owner and the Contractor will permit limited access to construction sites. Access by concerned citizens will be to assist the University in its stewardship responsibility of assuring taxpayer dollars and student fee monies are being expended in accordance with the intent of the Project. In no case will any such access permit interfere with the Work, or create additional Work, unless permitted by the Owner. The Contractor's employees and Subcontractors will not be interrupted, without the consent of the Contractor's Superintendent. Any access will require permission from the Director, and will be accompanied by the supervisor and/or their designee, as well as a representative of the Contractor if the Contractor so desires. Any such access will be scheduled by the Director with the Contractor's Superintendent.

ARTICLE 37 – CORRECTION OF WORK

A. The Contractor shall promptly remove from the Project all materials condemned by the Director as failing to conform to the Agreement, whether incorporated in the Work or not. The Contractor shall promptly replace and re-execute their own Work in accordance with the Agreement, without expense to the Owner and shall bear the expense of making good all work of other Contractors destroyed or damaged by such removal or replacement.

B. Neither the final certificate, nor payment, nor any provision in the Contract Documents shall relieve the Contractor and the Surety of responsibility for faulty materials or workmanship, and, unless otherwise specified, the Contractor or their sureties shall remedy any defects due thereto and pay for any damage to their work resulting therefrom, which shall appear within a period of one year from the date of Substantial Completion and acceptance of the Work. The Owner shall give notice of observed defects with reasonable promptness.

ARTICLE 38 – SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

A. Shop Drawings, Product Data, Samples, and similar submittals (collectively referred to as “Submittals”) are not Contract Documents. Their purpose is to demonstrate the way in which the Contractor proposes to conform to the information given and the design concept set forth by the Contract Documents for those portions of the Work for which submittals are required. Informational submittals that do not require response by the Consultant may be identified as such in the Contract Documents. Submittals that are not required by the Contract Documents may be returned to the Contractor without action.

B. The Contractor shall include the cost of providing Shop Drawings, Product Data, Samples, and similar submittals in the bid, including the cost of shipping and delivery to the appropriate location as required by the Contract Documents.

C. Submittals shall be provided on a submittal log and schedule and conveyed to the necessary parties in a manner as agreed upon between the Owner, Contractor, and Consultant. The Contractor shall provide a schedule for submittals within thirty (30) days after the issuance of the Notice to Proceed. Submittals shall be provided in a timely fashion and sequenced during the Project so as to avoid delays to the Work of this Agreement as well the activities of the Owner and any separate contractors.

(1) Digital submittals, log and schedule are preferred unless directed otherwise.

(2) Three (3) samples shall be submitted for review.

D. The Contractor shall review all submittals required by the Contract Documents for compliance with the Contract Documents and shall mark submittals with their approval prior to providing submittals to the Consultant. Each Submittal shall be provided with the cover sheet in Appendix A and shall bear a stamp or specific indication that the submittal has been reviewed by the Contractor and complies with the Contract Documents. Such stamp shall represent that the Contractor has satisfied its obligations under the Contract Documents with respect to Contractor’s review and has approved that Submittal. The stamp shall include the Contractor’s company name as well as the signature of the representative of Contractor who approved the submittal. In addition to the above stamp, the cover sheet for each submittal shall bear the following:

- (1) The Owner’s name listed simply as “Missouri State University” for this purpose.
- (2) The Owner’s Project Title as indicated on the Contract Documents.
- (3) The Owner’s Project number.
- (4) The Owner’s lead Consultant for the project.
- (5) The applicable specification section number and specification section title.
- (6) In instances where the specification section title does not accurately provide a description of the item(s) included in the submittal, a description of the item(s) that are included in the submittal shall be provided below the specification section title.
- (7) The company name, address, and contact information of the responsible Subcontractor (if applicable).
- (8) The company name, address, and contact information of the manufacturer, supplier, distributor, or fabricator for the submitted item(s) (If applicable).
- (9) Any additional information as required by the Contract Documents.

E. By providing Shop Drawings, Product Data, Samples, and similar submittals, the Contractor represents to the Owner and Consultant the following:

- (1) That the Contractor has determined and verified field measurements and field construction criteria related to the submitted item(s).
- (2) That the Contractor is responsible for the correctness and accuracy of the dimensions, measurements, and other information contained in the Submittal.
- (3) That the submitted items are fit for their intended use.
- (4) That the fabrication, shipping, handling, storage, assembly and installation of all materials, systems and equipment are in accordance with best practices in the industry and are in strict compliance with any applicable requirements of the Contract Documents.
- (5) That the Contractor is responsible for coordination of each Submittal with other Submittals and has checked and coordinated the information contained within such Submittals with all of the Work required by the Contract Documents.

F. The Contractor shall not perform any portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples, or similar submittals until the respective submittal has been approved by the Consultant or Owner's appointed representative.

G. The Work shall be in accordance with the approved submittals except that the Contractor shall not be relieved of responsibility for deviations from the requirements of the Contract Documents by the Consultant's approval of Shop Drawings, Product Data, Samples, or similar submittals unless the Contractor has specifically informed the Consultant in writing of such deviations at the time of the submittal and the Consultant done one of the following:

- (1) Provided written approval to the specific deviation as a minor change in the Work.
- (2) Issued a Change Order authorizing the deviation.

H. Approval of Shop Drawings, Product Data, Samples, or similar submittals by the Consultant shall not relieve the Contractor of responsibility for any errors or omissions in said Shop Drawings, Product Data, Samples, or similar submittals.

I. The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples or similar submittals, to revisions other than those requested by the Consultant on previous Submittals. In the absence of such written notice, the Consultant's approval of a resubmission shall not apply to such revisions.

J. The Contractor represents and warrants that all Shop Drawings shall be prepared by persons and entities possessing expertise and experience in the trade for which the Shop Drawing is prepared and, if required by the Contract Documents or applicable Laws, by an appropriately licensed architect, engineer, or other licensed design professional.

K. There shall be no limitations on reproduction placed on any submittal provided to the Consultant or to the Owner. The Owner retains the right to copy and distribute submittals as necessary. Any such limiting statement placed on a submittal shall not be recognized by the Owner and shall be found to be void. The Contractor shall require the same to any level tier Subcontractor or supplier.

ARTICLE 39 – OPERATION AND MAINTENANCE MANUALS

A. Assemble operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual specification sections and including, but not necessarily limited to, the following:

- (1) Operation Data:
 - (a) Emergency Instructions and procedures.

- (b) System, subsystem, and equipment descriptions, including operating standards.
 - (c) Operating procedures, including startup, shutdown, seasonal change over, and weekend operations. Operating procedures shall include a written step-by-step guide and/or video for safe and efficient operation of all equipment and shall include trouble shooting guides.
 - (d) Description of controls and sequence of operations.
 - (e) Piping and wiring diagrams.
- (2) Maintenance Data:
- (a) Provide an equipment list of all major equipment as installed. Include information on all lighting fixtures incorporated into the Work. Information shall include manufacturer name, model number, name plate data, capacities, flow rates, electric characteristics, filter size(s), belt size(s), other recommended spare parts (including model numbers), recommended tools for service, etc.
 - (b) Provide maintenance data for all finish materials used in the Work. Information shall include manufacturer name; model number, name or make; recommended cleaning intervals, cleaning methods, methods for spot cleaning or repairing damage, etc.
 - (c) Name, address, and telephone number of installer and supplier.
 - (d) Maintenance procedures.
 - (e) Maintenance and service schedules for preventive and routine maintenance.
 - (f) Maintenance record forms.
 - (g) Parts catalogs and sources of spare parts and maintenance materials. Parts catalogs shall include components identified by number for replacement ordering.
 - (h) Copies of maintenance service agreements.
 - (i) Copies of manufacturer's certificates of warranties and bonds. Provide warranties as required by the General Conditions and individual specification sections.

B. Provide two (2) printed copies of Operation and Maintenance Manuals and one (1) electronic copy in PDF format. All materials contained in the Operation and Maintenance Manuals shall be manufacturer's standard, professionally printed or electronically produced material. Photo copies of printed material or scanned copies of electronic documents shall not be acceptable.

- (1) Printed copies shall be bound and indexed into heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Organize hard copies of Operation and Maintenance Manuals into suitable sets of a manageable size. Provide tabs to divide sections within each manual and include a table of contents to reference each sections by tab number. Identify each binder on the spine with the printed title "OPERATION AND MAINTENANCE MANUAL"; Project location and title as listed on the Contract Documents; the Owner's project number as listed on the Contract Documents; and if more than one volume is provided, the volume number of the manual. On the front of each volume of the Operation and Maintenance manual provide a coversheet that includes the information listed below.

- (2) Electronic copies shall include a table of contents that matches the printed copy. Each item in the table of contents shall be linked to the appropriate material within the body of the manual.
- (3) A coversheet shall be provided for both the electronic copy and any printed copies of the Operation and Maintenance manuals and shall include the following information:
 - (a) The printed title "OPERATION AND MAINTENANCE MANUAL".
 - (b) The project title and location as listed on the Contract Documents.
 - (c) The Owner's project number as listed on the Contract Documents.
 - (d) The name of the Contractor and their contact information.
 - (e) For printed copies, if multiple volumes are required the following additional information shall be provided:
 - 1. The volume number
 - 2. The subject matter included in the volume (e.g. Architectural, Plumbing, Fire Protection, Mechanical, Electrical, etc. A more detailed breakdown of the subject matter may be provided as appropriate. For example; Finishes, Doors and Hardware, Elevator, Audio/Visual Systems, Lighting Control, etc.)

C. Upon 80% completion of the total Agreement, the Contractor shall deliver the Operation and Maintenance Manuals to the Owner for review and approval. If a Consultant is employed on the Project, the Operating and Maintenance Manuals shall be submitted directly to the Consultant for review. A copy of the transmittal sent to the Consultant with the Operating and Maintenance Manuals shall be sent to the Owner at the same time.

D. Payment and retainage beyond the limit stated above shall not be due to and owed to the Contractor until the final approved Operation and Maintenance Manuals are delivered to the Owner.

ARTICLE 40 – RECORD DRAWINGS

A. General: The Contractor shall maintain one set of black-line white prints of Record Drawings. Record Drawings shall be kept on site in good condition and shall use a color other than black ink to markup said set with "record information" in a legible manner. Do not use Project Record Drawings for construction purposes. Protect Project Record Drawings from deterioration and loss. Provide access to Project Record Drawings for Owner's and Consultant's reference during normal working hours.

- (1) Mark Record Drawings to show where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is installer, Subcontractor, or similar entity, to prepare the marked-up Record Drawings
 - (a) Record changes to existing conditions or existing conditions found to be different from those shown on the original drawings.
 - (b) Information indicated on Record Drawings shall include, but not necessarily be limited to, the actual installed position of equipment, piping, conduit, light switches, electric fixtures, ducts, dampers, access panels, control valves, drains, openings, and stub outs.
 - (c) Indicate actual circuiting of lighting fixtures, receptacles, and other electrical devices and equipment.

- (d) Update the project finish schedule to include detailed information of actual finishes selected and installed including, but not necessarily limited to, paint colors, plastic laminate selections, floor coverings, wall coverings, ceiling systems, etc.
 - (e) Include other information as reasonably requested by either the Owner or the Consultant.
 - (f) Give particular attention to information on concealed elements that cannot be readily identified and recorded later.
 - (g) Accurately record information in an understandable drawing technique.
 - (h) Provide photo documentation where it might provide a better understanding of as-built conditions.
 - (i) Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
- (2) Mark record sets with a color other than black ink to provide contrast between recorded information and original prints. Use other differing colors as required to distinguish between changes for different categories of the Work at the same location.
 - (3) Mark important additional information that was either shown schematically or omitted from original Drawings.
 - (4) Include changes to the Work incorporated into the project by Addendum, Construction Change Directive, Change Order, etc.
 - (5) Clearly mark alternates that were accepted and incorporated into the Work and indicate alternates not accepted by prominently noting as such.
 - (6) Include additional information on Record Drawings as required by individual specification sections included in the Project Manual.
 - (7) Identify and date each Record Drawing; include the designation "RECORD DRAWING" in a prominent location. Organize into manageable sets; bind each set. Include identification on cover sheets.

B. Upon Substantial Completion of the Work the Contractor shall deliver the Record Drawings to the Owner for review and approval. If a Consultant is employed on the Project, the Record Drawings shall be submitted directly to the Consultant for review. A copy of the transmittal sent to the Consultant with the Record Drawings shall be sent to the Owner at the same time.

C. Final payment and retainage shall not be due to and owed to the Contractor until the final approved Record Drawings marked by the Contractor as required above are delivered to the Owner.

SUBCONTRACTORS

ARTICLE 41 – SUBCONTRACTS

A. The Contractor agrees to be fully responsible to the Owner for the acts and omissions of subcontracts and of persons either directly or indirectly employed by them as is the subcontractor responsible for the acts and omissions of persons directly employed by them. The Contractor will advise all Subcontractors of these General Conditions and all obligations hereunder.

A. Nothing contained in the Contract Documents shall create any contractual relation between any Subcontractor and the Owner.

ARTICLE 42 – ASSIGNMENT

A. The Contractor shall not assign the Agreement or sublet it as a whole without the written consent of the Owner, nor shall the Contractor assign any moneys due or to become due to the Contractor hereunder, without the previous written consent of the Owner.

WORK BY OWNER OR SEPARATE AGREEMENTS

ARTICLE 43 – SEPARATE AGREEMENTS

A. The Owner reserves the right to let other Agreements in connection with this Work. The Contractor shall afford other Contractors reasonable opportunity for the introduction and storage of their materials and the execution of their work and shall properly connect and coordinate his work with theirs.

B. If any part of the Contractor's work depends, for proper execution or results, upon the work of any other Contractor, the Contractor shall inspect and promptly report to the Owner any defects in such work that render it unsuitable for such proper execution and results. His failure to so inspect and report shall constitute an acceptance of the other Contractor's work as fit and proper for the reception of his work except as to defects which may develop in the other Contractor's work after the execution of his work and which were not discoverable at the time of inspection. To ensure the proper execution of his subsequent work, the Contractor shall measure work already in place and shall at once report to the Owner any discrepancies between the executed Work and the Contract Documents.

ARTICLE 44 – MUTUAL RESPONSIBILITY OF THE CONTRACTORS

A. Should this Contractor cause damage to any other Contractor on the Work, this Contractor agrees, upon due notice, to settle with such Contractor by agreement or arbitration if they will so settle. If such Contractor sues the Owner on account of any damage alleged to have been so sustained, the Owner shall notify the Contractor who shall defend such proceedings; and, if any judgment against the Owner arises therefrom, the Contractor shall pay or satisfy it and pay all costs incurred by the Owner.

SCHEDULE AND PROGRESS OF THE WORK

ARTICLE 45 – CONTRACTOR'S CONSTRUCTION SCHEDULE

A. The Contractor, within fifteen (15) calendar days after the issuance of the Notice to Proceed, shall prepare and submit for the Owner's and Consultant's information a Contractor's construction schedule for the Work and shall set forth interim dates for completion of various components of the Work as defined within the Contract Documents. The schedule shall not exceed time limits defined within the Contract Documents, shall be revised at appropriate intervals as required by the conditions of the Work, and shall provide for expeditious and practicable execution of the Work.

B. The construction schedule shall be in a detailed format satisfactory to the Owner and the Consultant. If the Owner or Consultant has a reasonable objection to the schedule submitted by the Contractor, the construction schedule shall be promptly revised by the Contractor. The Contractor shall monitor the progress of the Work for conformance with the requirements of the construction schedule and shall promptly advise the Owner of any delays or potential delays. Additionally, the Contractor shall submit a revised schedule at intervals as requested by the Owner.

C. In the event the Owner or Consultant determines that the performance of the Work has not progressed or reached the level of completion required by the Contract Documents, the Owner shall have the right to order the Contractor to take corrective measures necessary to expedite the progress of construction, including, without limitation:

- (1) working additional shifts or overtime,
- (2) supplying additional manpower, equipment, facilities, and
- (3) expediting delivery of materials

Such measures shall continue until the progress of the Work complies with the stage of completion required by the Contract Documents. The Owner's right to require said measures is solely for the purpose of ensuring the Contractor's compliance with the construction schedule. The Contractor shall not be entitled to an adjustment in the Agreement sum concerning said measures required by the Owner. The Owner may exercise the rights furnished by the Owner as frequently as the Owner deems necessary to ensure that the Contractor's performance of the Work will comply with the completion date set forth in the Contract Documents.

D. The Owner reserves the right to supplement labor in the event the Owner or Consultant, in its sole discretion, determines that supplementation is necessary. Such supplementation will reduce or offset the Agreement price due the Contractor.

ARTICLE 46 – REVIEW OF WORK

A. The Consultant and the Owner shall, at all times, have access to the Work; and the Contractor shall provide proper facilities for such access.

B. The Consultant's review of the Work is for the purpose of assuring the Owner that the Contract Documents are being properly executed.

C. The fact that the Consultant or the Owner Representative has failed to observe faulty work, or work done which is not in accordance with the Contract Documents, shall not relieve the Contractor from responsibility for correcting such work without additional compensation.

D. If laws, ordinances, any public authority or these Contract Documents require any work to be specifically tested or approved, the Contractor shall give the Owner timely notice of date fixed for testing.

E. The Consultant or the Director may require project coordination meetings that shall be attended by representatives of the Contractor and appropriate Subcontractors. Material suppliers shall attend coordination meetings if required by the Consultant or Director.

CHANGES IN THE WORK

ARTICLE 47 – CHANGES AND ALTERATIONS

A. The Owner, without giving notice to the Surety and without invalidating the Agreement, may order extra work or make changes by altering, adding to or deducting from the Work, the Agreement sum being adjusted accordingly, subject to the limitations of the Agreement. All such work shall be executed under the conditions of the original Agreement.

B. In giving instructions, the Director shall have authority to make minor changes in the Work, not involving extra cost, and not inconsistent with the purposes of the building, but otherwise, except in an emergency endangering life or property, no extra work or change shall be made unless in pursuance of a written change order from the Owner. No claims for an addition to the Agreement sum shall be valid unless so ordered.

C. If changes are ordered, the Owner's representative shall value and appraise such changes and add to or deduct from the amount to be paid to the Contractor the excess of any deficiency. Before such changes are made they shall be stated in writing to the Contractor by the Owner with the approval of the Director and with his endorsed approval, the appraisal shall be binding upon all parties hereto.

ARTICLE 48 – CHANGE ORDERS

A. The Owner, as authorized by its governing body, may authorize written Change Orders regarding changes in, or additions to, Work to be performed or materials to be furnished pursuant to the provisions of the Agreement.

B. The amount of adjustment in the Agreement price for authorized Change Orders will be agreed upon before such Change Orders become effective and will be determined as follows:

- (1) By an acceptable unit price or lump sum proposal from the Contractor and the Subcontractors of any tier. Breakdowns shall be of sufficient detail to allow evaluation by the Owner and include a listing of each item of material with Unit Prices and number of hours of labor for each task.
- (2) By a time and material basis with or without a specified maximum, including all overhead and profit, total cost not to exceed maximum specified. The Owner's Representative will approve the Contractor's time and material for the Work. Time must be submitted on daily time sheets.
- (3) The Contractor shall submit labor rates for all Subcontractors.

C. Overhead and profit on Change Orders shall be applied as follows:

- (1) The overhead and profit charged by the Contractor shall be considered to include, but not limited to, payment and performance bond, builder's risk and public liability insurance, job site office expense, normal hand tools, incidental job supervision, field supervision, company benefits, and general office overhead. The percentages for overhead and profit charged on Change Orders shall be negotiated and may vary according to the nature, extent, and complexity of the Work involved but in no case shall exceed the following:
Overhead and Profit

15% To the Contractor or the Subcontractor of any tier for Work performed with their respective forces or materials purchased.

5% To the Contractor on Work performed by other than his forces.

5% To first tier Subcontractor on Work performed by his Subcontractor.

Not more than three mark-ups, not to exceed individual maximums shown above, shall be allowed regardless of the number of tier Subcontractors. Overhead and profit shall be shown separately for each Subcontractor of any tier and the Contractor.

- (2) On proposals covering both increases and decreases in the amount of the Contract, the application of overhead and profit shall be on the net change in direct cost for the Contractor or Subcontractor of any tier performing the Work.
- (3) The percentages for overhead and profit credit to the Owner on Change Orders that are strictly decreases in the quantity of work or materials shall be negotiated and may vary according to the nature, extent, and complexity of the Work involved, but shall not be less than the following:

Overhead and Profit

7.5% Credit to the Owner from the Contractor or Subcontractor of any tier for Work performed with their respective forces or materials purchased.

2% Credit to the Owner from the Contractor on Work performed by other than his forces.

2% Credit to the Owner from the first tier Subcontractor on Work performed by his Subcontractor of any tier.

D. The Contractor shall provide Change Order pricing and backup in a timely manner. No claim for an addition to the Agreement sum will be valid unless authorized in writing by the Owner. In the event that none of the foregoing methods are agreed upon, the Owner may perform Work by force account or accounts. The cost of such Work will be determined by the Contractor's actual labor and material cost to perform the Work plus applicable overhead and profit as outlined above.

E. No changes or additions to work to be performed, materials to be furnished, or in the provisions of the Agreement will be authorized until execution and delivery by the Owner to the Contractor of the written order referred to in this paragraph. Any work completed by the Contractor outside the original Project scope without written approval from the Owner will be deemed as a waiver by the Contractor for additional compensation for said work.

PAYMENTS AND COMPLETION

ARTICLE 49 – PAYMENT TO THE CONTRACTOR

A. Payments on account of this Agreement will be made monthly as the Work progresses. The Contractor shall submit to the Owner payment applications on the AIA G702 form or its equivalent and each shall have an original signature and notary seal on it. If requested, receipts or other vouchers showing Contractor's payments for materials and labor including payments to Subcontractors shall be included. The Owner shall retain five (5%) percent of the amount of each such estimate until Final Completion has been established and all closeout documents have been accepted by the Owner.

B. When a Consultant is involved, the Contractor shall submit an electronic payment application directly to the Consultant for review and approval, including Planning, Design and Construction on the electronic communication. At the same time, the Contractor shall provide to Planning, Design and Construction, Missouri State University, a copy of all lien waivers, and all payroll information. Lien waivers and payroll information do not need to go to the Consultant.

C. The Consultant will review the applications and either modify them as necessary, or when acceptable, approve the request by signing the electronic payment application. The Consultant will then send the approved electronic payment application directly to Planning, Design and Construction, and forward an electronic copy of the approved pay request to the Contractor to keep the Contractor informed of the approval process.

ARTICLE 50 – STORED MATERIALS

A. Payment for stored material will only be made for equipment or materials that are a major item of value and that span multiple applications for payment. Payment will not be made for miscellaneous items that are readily available from suppliers or materials that are delivered as needed on an ongoing basis.

B. No payment may be made for stored material that are not stored within the project limits or on property owned by the Owner. Stored material should be well-organized, stored under cover well protected from weather and vandalism. The Owner and Consultant should have access to inspect the materials as necessary. No payment shall be certified or approved for payment if not accompanied by the following:

- (1) Invoices that set forth quantities and price substantiating the Contractor's right to payment for stored materials MUST be submitted with each Application for Payment. If an invoice contains items that are not being requested for stored material payment, then the items for which stored material payment is requested shall be clearly denoted;
- (2) An insurance policy rider showing the Contractor has insured the materials against loss or damage by fire (with extended coverage), theft and burglary, with loss payable to the Owner;
- (3) Photographs showing the stored materials and its location;
- (4) "Schedule of values" shall include payment line items for all stored materials.

C. Exception may be considered for material stored in a third-party, bonded warehouse/storage facility located in the Springfield metropolitan area. The Owner or Consultant must verify that material is stored in a bonded warehouse/facility and that the stored material is segregated from other materials and

appropriately identified as Missouri State University property.

D. The risk and responsibility for the safety of materials stored off-site and in transit rests with the Contractor, Subcontractors, and Surety.

ARTICLE 51 – PAYMENTS WITHHELD

A. The Owner may withhold on account of subsequently discovered evidence, nullify in whole or in part any application for payment to such extent as may be necessary to protect the Owner from loss on account of:

- (1) Defective work not remedied or damaged work
- (2) Failure to supply sufficient skilled workers or suitable materials.
- (3) Failure of the Contractor to make payment properly to Subcontractors or for material or labor.
- (4) Claims filed or reasonable evidence indicating probable filing of claims.
- (5) A reasonable doubt that the Work cannot be completed for the unpaid balance of the Agreement sum.
- (6) Damage to the Owner or another Contractor.
- (7) A reasonable doubt that the Work will not be completed within the contract time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay.
- (8) Repeated failure to carry out the Work in accordance with the Contract Documents.
- (9) Failure to submit documents as requested in accordance with the Contract Documents.
- (10) Other reasons as permitted by Missouri law.

B. When the above grounds for withholding approval are removed, approval will be made for amounts withheld.

ARTICLE 52 – RELEASES

A. Neither the final payment nor any part of the retained percentage shall become due until the Contractor delivers to the Owner releases or lien waivers on a standard form from all persons supplying material or services for the Work described in the Agreement.

B. For the Contractor's convenience, a Final Waiver of Lien form is attached following the General Conditions in Appendix A. Other forms providing the same information may be used in place of this form.

ARTICLE 53 – ACCEPTANCE AND FINAL PAYMENT

A. Final application for payment shall be due at such time as the Work is fully completed and all provisions of the Agreement satisfactorily fulfilled.

B. When Final Completion has been accepted by the Owner, the Contractor shall submit a final application for payment. If the Owner approves the same, the entire balance found to be due to the Contractor, as noted in such final application for payment, shall be due and payable.

C. Before issuance of the final application for payment under this Agreement, the Contractor shall deliver or cause to be delivered to the Owner the closeout items mentioned below along with a verified copy of the Contractor Closeout Checklist included in Appendix A. The Contractor shall verify completion of each item by indicating on the form, the date that each item was provided and initialing the form in the appropriate adjacent space. The University is very interested in closing construction projects out in a timely manner and Contractors must be aware of and submit the items below. The following list is intended to aid the Contractor in properly gathering and submitting closeout items and is not intended to over-ride the requirement for any additional closeout items that may be required elsewhere in the Contract Documents.

- (1) Operation and maintenance manuals (Article 39 – Operation and Maintenance Manuals)
- (2) Warranties (Article 39 – Operation and Maintenance Manuals)
- (3) Operating and Training Instructions as required by the Contract Documents
- (4) Testing and Balancing Reports as required by the Contract Documents
- (5) Final Cleaning (Article 32 – Project Site Maintenance)
- (6) Request for Final Inspection (Article 36 – Inspection of Work)
- (7) Completion of Punch List (Article 54 – Prosecution and Completion of the Work)
- (8) Record Drawings (Article 40 – Record Drawings)
- (9) Properly executed final lien waivers or releases from all persons supplying material or services for the Work described in the Contract Documents (Article 52 – Releases)
- (10) An Affidavit for Compliance with Prevailing Wage Law, in the form as attached following the General Conditions in Appendix A, properly executed by each Subcontractor and the Contractor (Article 16 – Prevailing Wage)
- (11) Certified copies of all payrolls, consisting of name, occupation and craft, number of hours worked and actual wages paid for each individual, of the Contractor and all Subcontractors working on the project (Article 16 – Prevailing Wage)
- (12) Keys checked out thru Key Control or Residence Life for any purpose shall be returned and verification of such shall be made (Article 30 – Key Policy)
- (13) Spare parts and/or attic stock as required by Contract Documents and proof of delivery
- (14) Change orders (Article 48 – Change Orders)
- (15) Final payment application and supporting documentation (Article 49 – Payment to the Contractor)
- (16) All other items as required by the Contract Documents

ARTICLE 54 – EXECUTION AND COMPLETION OF THE WORK

A. The Contractor shall commence Work promptly in accord with the written "Notice to Proceed" as provided in these specifications. Contractor shall execute the Work vigorously and diligently so as to cause completion within the time stipulated in the Agreement.

B. If, in the opinion of the Contractor, the Contractor is delayed by any act or neglect of the

Owner, or any representative of the Owner, or by changes in the Work ordered in writing by the Owner, or any other cause beyond the reasonable control of the Contractor, the Contractor shall, within ten (10) calendar days from the start of such delay, enter written claim with the Director that such delay occurred.

C. Time is expressly declared to be the essence in completion of Work covered by the Contract Documents. It is agreed that the Owner may deduct from the Agreement price and retain as liquidated damages, and not as penalty or forfeiture, the sum stipulated in the accepted Agreement for each calendar day, Sundays and holidays included, after date specified for completion of the Project that the entire Work is not Substantially Complete.

D. When the Contractor considers that the Work, or portion thereof which the Owner agrees to accept separately, is Substantially Complete, the Contractor shall notify the Consultant and the Owner in writing, and shall submit to the Consultant together with such notice (1) a list of items to be completed or corrected, and (2) all permits, certificates, and special warranties required by the Contract Documents, endorsed by the Contractor and in a form reasonably acceptable to the Consultant. Such notice shall be given at least five (5) calendar days prior to the date stated for final inspection. Promptly after receiving such notice, list, permits, certificates, and special warranties, the Consultant will conduct a preliminary review to determine whether they are generally complete and correct. Failure to include an item on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents. If the Consultant finds on the basis of this review that the Contractor's notice and supporting documents are not generally complete or correct, the Consultant will return them to the Contractor for revision and resubmittal, describing in general the additions and/or corrections required. If the Consultant finds on a preliminary review of the Contractor's resubmittal, that the resubmitted notice and supporting documents are still not generally complete and correct, the Contractor shall again correct and resubmit them. The Contractor may be liable for any change in the Consultant's services resulting from such second and any subsequent preliminary reviews. When the Consultant finds on the basis of a preliminary review that the Contractor's notice and supporting documents are substantially complete and correct, the Consultant will proceed to perform a detailed inspection to determine that the requirements of the Contract Documents for Substantial Completion of the Work have been met. Upon making such a determination, the Consultant will prepare a Certificate of Substantial Completion that shall establish the Date of Substantial Completion of the Work. Warranties required by the Contract Documents shall commence upon the Date of Substantial Completion of the Work unless otherwise provided in the Certificate of Substantial Completion.

E. Certification by the Director of a complete or incomplete status of the Work within the time specified shall be conclusive and binding on the Owner and the Contractor for the purpose of determining whether liquidated damages shall be assessed under the terms hereof and the sum total amount due and deductible according thereto.

F. If Substantial Completion has not been given by the date set forth in the Agreement for Final Completion, the Owner without prejudice to any other rights, claims, or remedies has the right to liquidated damages, may back charge the Contractor for all additional expenses incurred by the Owner or Consultant as the result of the extended Agreement period and through final inspection.

G. Final Completion shall be established within 30 days of the date of Substantial Completion unless specified otherwise in writing. Failure to complete the project within this timeframe will allow the Owner the right to initiate liquidated damages in the amount set forth in these Contract Documents. Damages will be charged beyond the date of Final Completion for each calendar day the Work remains undone.

H. Liquidated damages or any matter related thereto shall not relieve the Contractor or his Surety of any responsibility or obligation under this Agreement.

I. The parties hereto realize in order to adjust satisfactorily the damages on account of such failure that it might be impossible to compute accurately or estimate the amount of such loss or damages which the Owner would sustain by reason of failure to complete fully said work within the time required by this contract, therefore it is specifically agreed that the amount fixed as liquidated damages herein is a reasonable forecast of just compensation for harm caused by delay.

ARTICLE 55 – GENERAL GUARANTEE

A. Neither the final application for payment nor any provision in the Contract Documents nor partial use or occupancy of the premises by the Owner shall constitute an acceptance of Work not done in accordance with the Contract Documents or relieve the Contractor or the Contractor's sureties of liability in respect to any express warranties or responsibility for faulty materials or workmanship.

B. Warranties required by the Contract Documents shall commence upon the Date of Substantial Completion of the Work unless otherwise provided in the Certificate of Substantial Completion. The Contractor or Contractor's sureties shall remedy any defects in the Work and pay for any damage to other work resulting therefrom which shall appear within a period of one year from the date of Substantial Completion unless a longer period is otherwise specified. The Owner will give notice of observed defects with reasonable promptness.

C. In case of default on the part of the Contractor in fulfilling this part of the Agreement, the Owner may correct the Work or repair the damage and the cost and expense incurred in such event shall be paid by or recoverable from the Contractor.

TERMINATION OF THE AGREEMENT

ARTICLE 56 – OWNER'S RIGHT TO TERMINATE AGREEMENT

A. If the Contractor shall be adjudged a bankrupt, or make a general assignment for the benefit of creditors, or if a receiver should be appointed on account of the Contractor's insolvency, or the Contractor should refuse or should fail to make prompt payment to Subcontractors or for material or labor, or disregard payment to Subcontractors or for material or labor, or disregard laws, ordinances or the instruction of the Owner, or otherwise breach any provision of the Agreement, then the Owner, if the Owner decides sufficient cause exists to justify such action, may, without prejudice to any other right or remedy and after giving the Contractor seven (7) days written notice, terminate the employment of the Contractor and take possession of the premises and of all materials, tools and appliances thereon and finish the Work by whatever method the Owner may deem expedient. In such case the Contractor shall not be entitled to receive any further payment until the Work is finished.

B. If the Contractor refuses or fails to prosecute the Work or any separate part thereof with such diligence as will ensure its completion within the time specified, or fails to terminate the Contractor's right to proceed with the Work or such parts of the Work as to which there has been delay, in such event the Owner may take over the Work and prosecute the same to completion, by the Agreement or otherwise, and the Contractor and the Contractor's sureties shall be liable to the Owner for any excess cost occasioned the Owner thereby. If the Contractor's right to proceed is so terminated, the Owner may take possession of and utilize in completing the Work such materials, appliances and paint as may be on the site of the Work and necessary, therefore.

C. The Owner shall have the right to terminate this Agreement for convenience (for any reason and without cause) by providing written notice to the Contractor at least (3) three days in advance of the date the Owner requires the Contractor to stop work, and on such date the Agreement shall be deemed terminated. Upon termination of this Agreement for convenience, the Owner shall be released immediately from any and all obligations to the Contractor except for the payment set out herein. The Contractor immediately shall discontinue the Work and remove its personnel and equipment from the Project, and the Owner shall be entitled to take exclusive possession of the Project and all or any part of the Project and materials delivered or in route to the Project. The Contractor shall take immediately such steps as are reasonably necessary to preserve and protect Work completed and in progress and to protect materials, equipment and supplies at the Project, stored off-site, or in transit. If requested by the Owner, the Contractor will make every reasonable effort to cancel existing contracts with Subcontractors upon terms reasonably satisfactory to the Owner. Any payments to be made to a Subcontractor as a result of any such termination shall be paid by the Contractor and shall be included in the calculation of the payment due hereunder, if any. The Contractor shall also, upon request by the Owner, (a) to the extent assignable, irrevocably assign and deliver to the Owner any and all Subcontracts, purchase orders, bonds and options made by the Contractor in performance of the Work, (b) provide to the Owner without charge all rights of the Contractor to use patented or proprietary materials of the Contractor and

Subcontractors in completing, operating and maintaining the Project, and (c) deliver to the Owner originals of all Contract Documents and, if the termination occurs at a time when the design of the Project is incomplete, originals of all design documents in process (except that the Contractor may keep for its records copies, and, if sufficient originals exist, an original set, of the Contract Documents executed by the Owner), all other materials relating to the Work which belong to the Owner, and all papers and documents relating to Permits, orders placed, bills and invoices, lien releases and financial management under this Agreement. All deliveries hereunder shall be made free and clear of any liens, security interests or encumbrances, except such as may be created by the Owner. Except as provided herein, no action taken by the Owner or the Contractor after the termination of this Agreement shall prejudice any other rights or remedies of the Owner or the Contractor provided by Governing Law, the Contract Documents or otherwise upon such termination. Termination of this Agreement under this Article shall not relieve the Owner or the Contractor of any obligation hereunder which expressly or by implication survives termination hereof. This Article shall survive the termination or expiration of this Agreement. If the Owner terminates this Contract for convenience and the Contractor fulfills its obligations under this subpart (c), then the Contractor will be paid a reasonable termination charge equal to the percent of the Agreement price reflecting the amount of the Work performed properly before the termination notice that has not been paid already by the Owner, plus any retainage related to Work performed properly before the termination notice. The Contractor will not be paid for any work performed after termination or for any reasonably avoidable costs incurred by the Contractor or the Contractor's subcontractors after receipt by the Contractor of the termination notice, including any demobilization costs associated with termination for convenience. The Contractor will not be entitled to any payment of any claim of lost profits or overhead on Work not performed. Payment of the payment set out in this subpart (c) shall be the sole and exclusive liability of the Owner, and the sole and exclusive remedy of the Contractor, with respect to termination of this Agreement for convenience and in such event the Owner shall have no further liability to the Contractor notwithstanding the actual amount of damages that the Contractor may have sustained in connection with such termination. The payment set out herein been agreed upon and fixed hereunder because of the difficulty of ascertaining the exact amount of such damages the Contractor will actually sustain in the event of a termination of this Agreement for convenience, and the Owner and the Contractor agree that the calculation of the payment in this subpart (c) is reasonable.

SUPPLEMENTAL CONDITIONS – AMERICAN RESCUE PLAN ACT (ARPA)

All Subrecipients/Contractors receiving a subaward to carry out a part of a federal program or for the purpose of providing goods and services must adhere to the following:

- **Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards** (2 CFR Part 200):
<https://www.ecfr.gov/current/title-2/subtitle-A/chapter-II/part-200?toc=1>
- **Buy America Preferences for Infrastructure Projects** (2 CFR Part 184): <https://www.ecfr.gov/current/title-2/subtitle-A/chapter-I/part-184>
- **Universal Identifier and System for Award Management (“SAM”)** (2 CFR Part 25), pursuant to which the award term set forth at Appendix A to 2 C.F.R. Part 25 is hereby incorporated by reference.
- **Reporting Subaward and Executive Compensation Information** (2 C.F.R. Part 170), pursuant to which the award term set forth at Appendix A to 2 C.F.R. Part 170 is hereby incorporated by reference.
- **Division B, Title V, Section 505 of Public Law 115-245, Consolidated Appropriations Act, 2019** requiring specific disclosures when making public announcements related to the use of the federal funds.
- **OMB Guidelines to Agencies on Governmentwide Debarment and Suspension** (2 CFR Part 180).
- **Drug-Free Workplace** (2 CFR 3186 and 2 CFR 182).
- **New Restrictions on Lobbying** (31 CFR Part 21).
- **Uniform Relocation Assistance and Real Property Acquisitions Act of 1970** (42 U.S.C. 4601- 4655) and implementing regulations.
- **Title VI of the Civil Rights Act of 1964** (42 U.S.C. §§ 2000d et seq.) and Treasury’s implementing regulations at 31 C.F.R. Part 22, which prohibit discrimination on the basis of race, color, or national origin under programs or activities receiving federal financial assistance.
- **The Fair Housing Act**, Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§ 3601 et seq.) which prohibits discrimination in housing on the basis of race, color, religion, national origin, sex, familial status, or disability.
- **Section 504 of the Rehabilitation Act of 1973**, as amended (29 U.S.C. § 794), which prohibits discrimination on the basis of disability under any program or activity receiving federal financial assistance.
- **Title IX of the Education Amendments of 1972**, as amended (20 U.S.C. §§1681–83,1685–86), which prohibits discrimination on the basis of sex in education programs.
- **The Age Discrimination Act of 1975**, as amended (42 U.S.C. §§ 6101 et seq.) and Treasury’s implementing regulations at 31 C.F.R. Part 23, which prohibit discrimination on the basis of age in programs or activities receiving federal financial assistance.
- **Title II of the Americans with Disabilities Act of 1990**, as amended (42 U.S.C. §§ 12101 et seq.), which prohibits discrimination on the basis of disability under programs, activities, and services provided or made available by state and local governments or instrumentalities or agencies thereto.

- **Hatch Act**: Grantee agrees to comply, as applicable, with requirements of the Hatch Act (5 U.S.C. §§ 1501–1508 and 7324–7328), which limit certain political activities of State or local government employees whose principal employment is in connection with an activity financed in whole or in part by this federal assistance.
- **False Statements**: Grantee understands that making false statements or claims in connection with this award is a violation of federal law and may result in criminal, civil, or administrative sanctions, including fines, imprisonment, civil damages and penalties, debarment from participating in federal awards or contracts, and/or any other remedy available by law.
- **Publications**: Any publications produced with funds from this grant must display the following language:

“This product is being supported, in whole or in part, by federal award number SLFRP4542 awarded to State of Missouri by the U.S. Department of the Treasury.”

- **Debts Owed State and Federal Government**: Any funds paid to Grantee (1) in excess of the amount to which Grantee is finally determined to be authorized to retain under the terms of this grant; (2) that are determined by the Treasury Office of Inspector General to have been misused; or (3) that are determined by Treasury to be subject to a repayment obligation pursuant to sections 602(e) and 603(b)(2)(D) of the Act and have not been repaid by Grantee shall constitute a debt owed by the State to the federal government. In such instance, the funds constituting the State’s debt to the federal government shall also constitute Grantee’s debt to the State. Debts owed by Grantee to the State must be paid promptly by Grantee. A debt owed the State by Grantee under this agreement is delinquent if it has not been paid by the date specified in the State’s initial demand for payment, unless other satisfactory arrangements have been made or if Grantee knowingly or improperly retains funds that are a debt as defined in this paragraph. The State will take any actions available to it to collect such a debt, including but not limited to actions available to it under the “Remedial Actions” paragraph found in this same section (I) above. The rights of the State as expressed in this paragraph are in addition to, and do not imply the exclusion of, any other rights the State may have under applicable law to collect a debt or seek damages from Grantee. Disclaimer: In its award of federal financial assistance to the State, Treasury provides that the United States expressly disclaims any and all responsibility or liability to the State or third persons for the actions of the State or third persons resulting in death, bodily injury, property damages, or any other losses resulting in any way from the performance of this award or any other losses resulting in any way from the performance of this award or any contract or subcontract under this award. Furthermore, in its award of federal financial assistance to the State, Treasury also states that the acceptance of this award by the State does not in any way establish an agency relationship between the United States and the State. This disclaimer applies with equal force to this grant.
- **Protections for Whistleblowers**: For grants to subrecipients exceeding \$250,000: In accordance with 41 U.S.C. § 4712, Grantee may not discharge, demote, or otherwise discriminate against an employee in reprisal for disclosing to any of the list of persons or entities provided below, information that the employee reasonably believes is evidence of gross mismanagement of a federal contract or grant, a gross waste of federal funds, an abuse of authority relating to a federal contract or grant, a substantial and specific danger to public health or safety, or a violation of law, rule, or regulation related to a federal contract (including the competition for or negotiation of a contract) or grant. The list of persons and entities referenced in the statement above includes the following:
 - i. a member of Congress or a representative of a committee of Congress;
 - ii. an Inspector General;
 - iii. the Government Accountability Office;
 - iv. a Treasury employee responsible for contract or grant oversight or management;
 - v. an authorized official of the Department of Justice or other law enforcement agency;
 - vi. a court or grand jury;

vii. a management official or other employee of the State or Grantee who has the responsibility to investigate, discover, or address misconduct. Grantee shall inform its employees in writing of the rights and remedies provided under this section, in the predominant native language of the workforce.

- **Increasing Seat Belt Use in the United States:** Pursuant to Executive Order 13043, 62 FR 19217 (Apr. 18, 1997), Contractors are encouraged to adopt and enforce on-the-job seat belt policies and programs for their employees when operating company-owned, rented or personally owned vehicles.
- **Reducing Text Messaging While Driving:** Pursuant to federal Executive Order 13513, 74 FR 51225 (Oct. 6, 2009), the State hereby encourages subrecipients to adopt and enforce policies that ban text messaging while driving.
- **Cash Management:** abide by the regulations governing Cash Management, available at 31 CFR 205 subparts A and B, et seq, to the extent applicable to all requests for reimbursement.
- **Use of Funds:** Subrecipient understands and agrees that the funds disbursed under this grant may only be used in compliance with section 602(c) of the Social Security Act (“Act”), as added by Section 9901 of the American Rescue Plan Act (“ARPA”), Pub. L. No. 117-2 (March 11, 2021), 135 Stat. 4, 223–26, and the U.S. Department of the Treasury (“Treasury”)’s regulations implementing that section and guidance, and in compliance with all other restrictions and specifications on use set forth in or applicable through this agreement. Subrecipient will determine prior to engaging in any project using this assistance that it has the institutional, managerial, and financial capability to ensure proper planning, management, and completion of the project. Signatory, on behalf of the subrecipient certifies to the best of their knowledge and belief that the institution will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing the ARPA.
- **Maintenance of and Access to Records:** Records shall be maintained by Subrecipient for a period of five (5) years after all funds have been expended or returned. Subrecipient shall maintain records and financial documents sufficient to evidence compliance with section 602(c) of the Act and Treasury’s regulations implementing that section and guidance regarding the eligible uses of funds.

Remedial Actions: The State reserves the right to impose additional conditions or requirements on Grantee’s receipt of this grant, as the State deems necessary or advisable, in order to facilitate compliance with any existing or additional conditions or requirements imposed upon the State by Treasury for the State’s receipt of ARPA funds. The State also reserves the right to seek recoupment or repayment of this grant in whole or in part, in the event that Treasury seeks recoupment or repayment of payments made to the State, for reasons relating to Grantee’s acts or omissions respecting this grant. These reservations are expressed without limitation to any other rights the State may hold, either to impose additional conditions or requirements on Grantee’s receipt of this grant or to recoup this grant in whole or in part, under this agreement or other applicable law.

SECTION 00 91 13 - ADDENDA

PART 1 - GENERAL

1.1 GENERAL

- A. If during the bidding period a Bidder finds discrepancies, ambiguities, omissions, or is in doubt as to the intent of the Contract Documents, notify the Architect immediately, but not less than three days prior to the Bid Date. All such necessary clarifications, information, interpretations or amendments shall be answered in the form of written Addenda to the Drawings and Project Manual, issued simultaneously to all holders of complete sets of Documents.
- B. No Addenda will be issued less than **forty-eight hours (2 days)** prior to the Bid Opening Date. The Architect shall not be responsible for oral interpretations or instructions during the Bidding Period.
- C. In the event of a conflict between the Plans and Specifications, it will be assumed that the greater quality and/or greater quantity of the two is intended.
- D. All Addenda are incorporated by reference into the Contract. Failure of any Bidder or Sub-Bidder to receive any Addenda shall not relieve the Bidder of any obligation with respect to his Bid.

END OF DOCUMENT 00 91 13

SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Work performed by Owner.
4. Work under Owner's separate contracts.
5. Owner-furnished/Contractor-installed (OFCI) products.
6. Owner-furnished/Owner-installed (OFOI) products.
7. Contractor-furnished/Owner-installed (CFOI) products.
8. Contractor's use of site and premises.
9. Coordination with occupants.
10. Work restrictions.
11. Unanticipated Conditions.
12. Specification and Drawing conventions.

- B. Related Requirements:

1. Section 01 50 00 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.
2. Section 01 73 00 "Execution" for coordination of Owner-installed products.

1.3 PROJECT INFORMATION

- A. Project Identification: Judith Enyeart Reynolds Complex

- B. Project Location: Site 1 – Art Annex
Missouri State University
1045 Grand Street
Springfield, MO 65897

Site 2 – Craig Hall
Missouri State University
1047 Grand Street
Springfield, MO 65897

- C. Owner: The Board of Governors of
Missouri State University

1. Owner's Representative: Michael Mardis

- D. Architect: Dake Wells Architecture
134 Park Central Sq, Suite 300
Springfield, Missouri, 65806
(833) 518 4545

1. Architect's Representative: Renee Sutterer

rsutterer@dake-wells.com

Cara Collins
ccollins@dake-wells.com

- E. Architect's Consultants: Architect has retained design professionals, who have prepared designated portions of the Contract Documents: Refer to Project Directory.
- F. Construction Manager: JE Dunn.
 - 1. Construction Manager Representative: David Atkisson
 - 2. Construction Manager for this Project is Project's constructor. The terms "Construction Manager" and "Contractor" are synonymous.
- G. Web-Based Project Software: A project Web site administered by Contractor will be used for purposes of managing communication and documents during the construction stage.
 - 1. See Section 01 30 01 "Administrative Requirements" and 01 31 00 "Project Management and Coordination." for requirements for establishing using web-based Project software.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following:
XXX
- B. Type of Contract:
 - 1. Project will be constructed under a single prime contract.

1.5 WORK PERFORMED BY OWNER

- A. Cooperate fully with Owner, so work may be carried out smoothly, without interfering with or delaying Work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.
- B. Preceding Work: Owner will perform the following construction operations at Project site. Those operations are scheduled to be substantially complete before Work under this Contract begins.
 - 1. X
- C. Concurrent Work: Owner will perform the following construction operations at Project site. Those operations will be conducted simultaneously with Work under this Contract.
 - 1. See Responsibility Matrix in drawings.
- D. Subsequent Work: Owner will perform the following additional work at site after Substantial Completion. Completion of that work will depend on successful completion of preparatory Work under this Contract.
 - 1. See Responsibility Matrix in drawings.

1.6 WORK UNDER OWNER'S SEPARATE CONTRACTS

- A. Work with Separate Contractors: Cooperate fully with Owner's separate contractors, so work on those contracts may be carried out smoothly, without interfering with or delaying Work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under Owner's separate contracts.

- B. Subsequent Work: Owner will award separate contract(s) for the following additional work to be performed at site following Substantial Completion. Completion of that work will depend on successful completion of preparatory work under this Contract.

1. See Responsibility Matrix in the drawings.

1.7 OWNER-FURNISHED/CONTRACTOR-INSTALLED (OFCI) PRODUCTS

- A. Owner's Responsibilities: Owner will furnish products indicated and perform the following, as applicable:

1. Provide to Contractor Owner-reviewed Product Data, Shop Drawings, and Samples.
2. Provide for delivery of Owner-furnished products to Project site.
3. Upon delivery, inspect, with Contractor present, delivered items.
 - a. If Owner-furnished products are damaged, defective, or missing, arrange for replacement.
4. Obtain manufacturer's inspections, service, and warranties.
5. Inform Contractor of earliest available delivery date for Owner-furnished products.

- B. Contractor's Responsibilities: The Work includes the following, as applicable:

1. Designate delivery dates of Owner-furnished products in Contractor's construction schedule, utilizing Owner-furnished earliest available delivery dates.
2. Review Owner-reviewed Product Data, Shop Drawings, and Samples, noting discrepancies and other issues in providing for Owner-furnished products in the Work.
3. Receive, unload, handle, store, protect, and install Owner-furnished products.
4. Make building services connections for Owner-furnished products.
5. Protect Owner-furnished products from damage during storage, handling, and installation and prior to Substantial Completion.
6. Repair or replace Owner-furnished products damaged following receipt.

- C. Owner-Furnished/Contractor-Installed (OFCI) Products:

1. See Responsibility Matrix in the drawings.

1.8 OWNER-FURNISHED/OWNER-INSTALLED (OFOI) PRODUCTS

- A. The Owner will furnish and install products indicated.

- B. Owner-Furnished/Owner-Installed (OFOI) Products:

1. See Responsibility Matrix in the drawings.

1.9 CONTRACTOR-FURNISHED/OWNER-INSTALLED (CFOI) PRODUCTS

- A. Contractor shall furnish products indicated. The Work includes unloading, handling, storing, and protecting Contractor-furnished products as directed and turning them over to Owner at Project closeout.

- B. Contractor-Furnished/Owner-Installed (CFOI) Products:

1. See Responsibility Matrix in the drawings.

1.10 CONTRACTOR'S USE OF SITE AND PREMISES

- A. Restricted Use of Site: Contractor shall have limited use of Project site for construction operations as indicated on **Drawing C1.3, as the Limits of Disturbance / Construction Fence Line** and as indicated by requirements of this Section. Contractor's use of premises is limited to new construction areas only. Contractor shall not enter the school premises outside of Contract limits during pick up and drop off times without approval from Humansville Public Schools. Work on renovated areas of existing site, utilities, buildings, and structures shall be performed with the approval and coordination with Owner.

- B. Limits on Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Limits on Use of Site: Confine construction operations to be within the Limits of Disturbance / Construction Fence area per XX.

2. Driveways, Walkways and Entrances: Keep driveways, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. **Do not use these areas or any curbside parking along Oak street for parking or for storage of materials.**
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
 3. Traffic Control: Contractor shall install temporary construction entrance, and take all necessary measures to ensure safe entry and exit, including signs, flagmen, coordination with City and Highway Department and other measures as required.
- C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight and fully operational condition throughout construction period unless otherwise noted. Repair damage caused by construction operations.
- D. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations. School operations to continue uninterrupted throughout construction.

1.11 COORDINATION WITH OCCUPANTS

- A. Full Owner Occupancy: Owner will occupy adjoining areas during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing services and roads unless otherwise indicated.
1. Maintain access to existing walkways or used facilities. Do not close or obstruct walkways, drives, parking or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
 2. Provide not less than **72** hours' notice to Owner of activities that will affect Owner's operations.
- B. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.
1. Architect will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.
 2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
 3. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
 4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.12 WORK RESTRICTIONS

- A. Comply with restrictions on construction operations.

1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work to between 7:00 a.m. to p.m. hour before sunset, whichever is earliest, or one-half hour before sunset, whichever is earliest, Monday or through Friday, unless otherwise indicated. Work hours may be modified to meet Project requirements if approved by Owner and authorities having jurisdiction.
 1. Weekend Hours: 8:00 a.m. to 5:00 p.m. or one-half hour before sunset, whichever is earliest.
 2. Early Morning Hours: As arranged with Owner.
 3. Work in Existing Building: As arranged with Owner.
 4. Hours for Utility Shutdowns: As arranged with Owner.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging for temporary utility services according to requirements indicated:
 1. Notify Construction Manager not less than two days in advance of proposed utility interruptions.
 2. Obtain Construction Manager's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Owner occupancy with Owner.
 1. Notify Construction Manager not less than two days in advance of proposed utility interruptions.
 2. Obtain Construction Manager's written permission before proceeding with utility interruptions.
- E. Smoking and Controlled Substance Restrictions: Use of tobacco products, alcoholic beverages, and other controlled substances **on Project site** is not permitted.

1.13 UNANTICIPATED CONDITIONS

- A. If in the course of work, the Contractor anticipates and/or discovers conditions and/or materials which are not identified in these construction documents, and/or which may be deemed unreasonably hazardous, and/or uncovers materials which are legally defined as hazardous, the Contractor is to stop work in the affected area and contact the Architect immediately. Do not proceed without written instructions from the Architect.
- B. The Contractor shall make every reasonable effort to inspect for unanticipated conditions, and to anticipate such conditions by prudent project planning and coordination.

1.14 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 16-division format and CSI/CSC's "MasterFormat" numbering system.
 1. Section Identification: The Specifications use Section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete because all available Section numbers are not used. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of Sections in the Contract Documents.
- B. 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. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
 - a. 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.
3. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
4. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
5. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- C. Division 00 Contracting Requirements: General provisions of the Contract, including General and Supplementary Conditions, apply to all Sections of the Specifications.
- D. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- E. 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 **scheduled on Drawings and published as part of the U.S. National CAD Standard.**
 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.
- F. The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all; performance by the Contractor 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.
- G. Coordinate with Owner for Owner's installation of miscellaneous equipment and furnishings.
- H. Coordinate with Owner for installation of AV/IT equipment and security equipment.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00

SECTION 01 21 00 - ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements governing allowances.
- B. Types of allowances include the following:
 - 1. Lump-sum allowances.
 - 2. Unit-cost allowances.
 - 3. Quantity allowances.
- C. Related Requirements:
 - 1. Section 01 22 00 "Unit Prices" for procedures for using unit prices, including adjustment of quantity allowances when applicable.
 - 2. Section 01 26 00 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.

1.3 DEFINITIONS

- A. Allowance: A quantity of work or dollar amount included in the Contract, established in lieu of additional requirements, used to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.

1.4 SELECTION AND PURCHASE

- A. At the earliest practical date after award of the Contract, advise Architect of the date when final selection, or purchase and delivery, of each product or system described by an allowance must be completed by the Owner to avoid delaying the Work.
- B. At Architect's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
- C. Purchase products and systems selected by Architect from the designated supplier.

1.5 ACTION SUBMITTALS

- A. Submit proposals for purchase of products or systems included in allowances in the form specified for Change Orders.

1.6 INFORMATIONAL SUBMITTALS

- A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.7 LUMP-SUM ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include freight and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
 - 1. If requested by Architect, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

1.8 UNIT-COST ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include freight and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
 - 1. If requested by Architect, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

1.9 QUANTITY ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include freight, and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
 - 1. If requested by Architect, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

1.10 ADJUSTMENT OF ALLOWANCES

- A. Allowance Adjustment: To adjust allowance amounts, base each Change Order proposal on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
 - 1. Include installation costs in purchase amount only where indicated as part of the allowance.
 - 2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
 - 3. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances.

4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
- B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the Purchase Order amount or Contractor's handling, labor, installation, overhead, and profit. Submit claims within 14 days of receipt of the Change Order or Construction Change Directive authorizing work to proceed. Owner will reject claims submitted later than 14 days after such authorization.
 1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.
 2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

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

3.3 SCHEDULE OF ALLOWANCES

- A. Allowance No. 1: Quantity Allowance: Include 1,600 cu. yd. of unsatisfactory soil excavation and disposal off-site and replacement with satisfactory soil material from off-site, as specified in Section 31 20 00 "Earth Moving."
 1. Coordinate quantity allowance adjustment with unit-price requirements in Section 01 22 00 "Unit Prices"

END OF SECTION 01 21 00

SECTION 01 22 00 - UNIT PRICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for unit prices.
- B. Related Requirements:
 - 1. Section 01 21 00 "Allowances" for procedures for using unit prices to adjust quantity allowances.
 - 2. Section 01 26 00 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.

1.3 DEFINITIONS

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

1.4 PROCEDURES

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, overhead, and profit.
- B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
- C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.
- D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the Part 3 "Schedule of Unit Prices" Article contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF UNIT PRICES

- A. Unit Price No. 1: "Mass rock" excavation and replacement with satisfactory soil material.
 - 1. Description: Classified mass rock excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, in accordance with Section 31 20 00 "Earth Moving."
 - 2. Unit of Measurement: 1 cubic yard of rock excavated, based on in-place surveys of volume before and after removal.
- B. Unit Price No. 2: "Trench rock" excavation and replacement with satisfactory soil material.
 - 1. Description: Classified trench rock excavation and disposal off-site, and replacement with satisfactory fill material or engineered fill from off-site, as required, in accordance with Section 31 20 00 "Earth Moving."

2. Unit of Measurement: 1 cubic yard of rock excavated, based on survey of in-place surveys volume of before and after removal.
- C. Unit Price No. 3: Unsuitable soil excavation, removal from site (spoils removal), and replaced with satisfactory engineered fill material, in accordance with Geotechnical Report.
1. Description: Unsatisfactory soil excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, in accordance with Geotechnical Report and Section 31 20 00 "Earth Moving." **Contractor shall include removal and replacement of 1,600 cubic yards per Section 01 21 00 "Allowances". Unit price will be used to adjust price if actual quantities vary.**
 2. Unit of Measurement: 1 cubic yard of soil excavated, based on in-place surveys of volume before and after removal.
 3. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 01 21 00 "Allowances."

END OF SECTION 01 22 00

SECTION 01 23 00 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

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

1.4 PROCEDURES

- A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1. Include, as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation, whether or not indicated as part of alternate.
- B. Execute accepted alternates under the same conditions as other Work of the Contract.
- C. Schedule: A Part 3 "Schedule of Alternates" Article is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

- A. **Art Annex:**
 - 1. NONE
- B. **Craig Hall**
 - 1. **Alternate No. 2.1: Lobby Glazing Replacement**
 - a. Base Bid: Includes replacing the vestibule on both the north and south vestibule. Repaint both interior and exterior steel mullions and cleaning interior and exterior glazing system within the Lobby.
 - b. Alternate: Selectively demo the existing single pane glazing and steel plate-work of the existing exterior curtain wall HSS's. The existing HSS's are to remain for the structure of the new glazing Veneer System to attach to. Provide new insulated glazing equal to Solarban 90.

2. **Alternate No. 2.2: Level 1, 2, & 3 Glazing System Replacement**

- a. Base Bid: Includes new glazing at Level 1 at the new restrooms and student lounge (south, east, 7 north elevations). Existing frames are to remain. See building elevations for scope of work.
- b. Alternate: Remove existing exterior full height glazing system, including doors and any remaining accessories, residue, and caulking at Level 1, all of level 2 and 3, excluding Lobby glazing replacement which is apart of alternate 2.1. Replace with a 2 ½" x 6 inch SSG curtainwall system with new insulated glazing equal to Solarban 90. See building elevations for scope of work.

3. **Alternate No. 2.3: NOT USED**

4. **Alternate No. 2.4: NOT USED**

5. **Alternate No. 2.5: Stair Renovations**

- a. Base Bid: Includes no work to inside all four existing stair towers.
- b. Alternate: Add renovations to all four existing stairwells, to include removing the existing wood and metal handrail on all sides of the stairs and replace with a steel painted guard railing. Remove all existing flooring and replace with resilient rubber tile at landings, treads and risers, and base. Patch, repair damaged walls and ceilings. Paint walls, ceilings, and stair stringers; no paint on the exposed concrete structure. Replace/upgrade all lighting and electrical devices. Replace/upgrade cabinet unit heaters. Coordinate with MEP drawings for related stairwell scope.

6. **Alternate No. 2.6: NOT USED**

7. **Alternate No. 2.7: Clean Exterior of Building**

- a. Base Bid: Includes cleaning of west elevation adjacent to the addition at level 1 and 2.
- b. Alternate: Clean the existing concrete and stone surfaces on all elevations. Clean, repair, and repaint soffit panels. Clean, remove rust and repaint machinal access panels and air intake grilles along the east, west, and south soffits. If it is more cost effective to replace with new access panels and grilles that is acceptable. Clean and relamp existing light fixtures with 3500K lamps at east, west, and south building soffits. The grilles, access panels, and fixture relamping in the north soffit occurred within the past year.

END OF SECTION 01 23 00

SECTION 01 25 00 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Section 01 21 00 "Allowances" for products selected under an allowance.
 - 2. Section 01 23 00 "Alternates" for products selected under an alternate.
 - 3. Section 01 60 00 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.
 - 4. Section 01 65 00 "Request for Substitutions During Bidding."

1.3 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents.
 - 1. 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.
 - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit documentation identifying 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.**
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
 - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitutions 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 as well as 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, from ICC-ES.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating 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 **three (3) days** of receipt of a request for substitution. Architect will notify Contractor through Construction Manager of acceptance or rejection of proposed substitution within **seven (7) days** of receipt of request, or **seven (7) 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.

1.5 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.

1.6 PROCEDURES

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

1.7 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than seven (7) days prior to time required for preparation and review of related submittals.
 - 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Requested substitution provides sustainable design characteristics that specified product provided for compliance with LEED requirements.
 - c. Substitution request is fully documented and properly submitted.
 - d. Requested substitution will not adversely affect Contractor's construction schedule.
 - e. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - f. Requested substitution is compatible with other portions of the Work.
 - g. Requested substitution has been coordinated with other portions of the Work.
 - h. Requested substitution provides specified warranty.
 - i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: **Not allowed unless otherwise indicated.**

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 25 00

SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Requirements:
 - 1. Section 01 25 00 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.
 - 2. Section 01 31 00 "Project Management and Coordination" for requirements for forms for contract modifications provided as part of web-based Project management software.

1.3 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on Architect's Supplemental Instructions.

1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Proposal Requests issued by Architect are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
 - 2. Within **10 days**, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include 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.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include an updated Contractor's 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.
 - d. **Include any General Conditions and staff or cost of the work general conditions that are associated with the change. If they are not included in the cost for the proposal request it is assumed that they are not being requested and they will not be granted at a future date.**
- B. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect .

1. Include 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.
2. Include 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.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. **Include any General Conditions and staff or cost of the work general conditions that are associated with the change. If they are not included in the cost for the proposal request, it is assumed that they are not being requested and they will not be granted at a future date.**
5. Include an updated Contractor's 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.
6. 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.

C. Proposal Request Form: Use AIA Document G709 for Proposal Requests.

1.5 MAXIMUM ALLOWANCE FOR OVERHEAD, PROFIT & LABOR BURDEN (need to coordinate with GC per MSU)

- A. Labor costs per hour shall be included with labor burden identified, which shall not be less than the prevailing wage rate, or actual labor rate, etc. Identify any labor burden costs over and above the prevailing wage rate. Labor burden costs shall not include overhead and profit charges as identifies below. In no case shall labor burden costs exceed 15% of the wage rate.
 1. Reference to wage rates is intended to include prevailing wage rates plus any additional fringe benefits that are part of the wage determination. The maximum Labor Burden of 15% is any additional labor mark ups over and above wage rates plus fringe benefits.
- B. The overhead and profit charge by the Contractor and all subcontractors shall be considered to include, but is not limited to: performance/payment bond, job site office expense, incidental job burdens, truck expense including mileage, small hand tools, project supervision including field supervision, company benefits and general office overhead and preparation of additional pricing submittals for the proposed work. Percentages for overhead and profit charged for Change Orders shall be negotiable and may vary according to the nature, extent, and complexity of the work involved. Percentage mark ups provided herein are intended to include the costs associated with all delay, disruption, extended job site presence and general office overhead resulting from the changed work.
- C. Contractor shall submit with schedule of values, a proposed hourly labor rate schedule for changes to the work for all major trades that includes prevailing wage rate, labor burden as described above. This labor rate once approved by the Architect and Owner will be the basis for the maximum hourly labor rate on any future changes to the work.
- D. The maximum Overhear and Profit shall be as follows:
 1. For the Contractor, for work performed by the Contractors' own forces, 15% of the cost, including bond.
 2. For the Contractor, for work performed by Subcontractors, 15% of amount due the subcontractor.
 3. For each Subcontractor or Sub-Subcontractor, a maximum of 15% over direct cost from the supplier for materials.
 4. For each Subcontractor, for work by his sub-subcontractor, 10% of the amount due the subcontractor.
 5. Overhead and Profit shall be shown separately for each subcontractor and the Contractor.

- E. On proposals covering both increases and decreases in the amount of this contract, the application of overhead and profit shall be on the net change in the cost of the work. Proposals must show items to be deleted, if any, and the cost of the change shall be the result of the net difference to the base contract. Proposals are not to be determined by a re-bid of the entire scope of work except where changes significantly alter the entire scope of a particular trade.
- F. The percentages for overhead and profit credit to the Owner on Change Orders that are solely decreases in the quantity of work or materials may be negotiated and may vary according to the nature, extent and complexity of the work involved, but in no case shall be less than fifteen percent (15%).

1.6 ADMINISTRATIVE CHANGE ORDERS

- A. Allowance Adjustment: See Section 01 21 00 "Allowances" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.
- B. Unit-Price Adjustment: See Section 01 22 00 "Unit Prices" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit-price work.

1.7 CHANGE ORDER PROCEDURES

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

1.8 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive instructing Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 - 1. 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: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
 - 1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 26 00

SECTION 01 29 00 - PAYMENT PROCEDURES (coordinate with MSU GC)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
 - 1. Section 01 21 00 "Allowances" for procedural requirements governing the handling and processing of allowances.
 - 2. Section 01 22 00 "Unit Prices" for administrative requirements governing the use of unit prices.
 - 3. Section 01 26 00 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 4. Section 01 32 00 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.3 DEFINITIONS

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

1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule. Cost-loaded CPM Schedule may serve to satisfy requirements for the Schedule of Values.
 - 1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:
 - a. Application for Payment forms with Continuation Sheets.
 - b. Submittals Schedule.
 - c. Contractor's Construction Schedule.
 - d. Schedule of payments.
 - 1. Submit the Schedule of Values to Architect at earliest possible date but no later than **seven (7) days** before the date scheduled for submittal of initial Applications for Payment.
- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section.
 - 1. Identification: Include the following Project identification on the schedule of values:
 - a. Project name and location.
 - b. Contractor's name and address.
 - c. Date of submittal.
 - 2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of the Work.

- c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value.
 - 1) Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.
4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
- a. Differentiate between items stored on-site and items stored off-site. If specified, include evidence of insurance or bonded warehousing.
6. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Allowances: Provide a separate line item in the Schedule of Values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
8. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
- a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
9. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include each Change Order as a new line item.

1.5 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments, as certified by Architect and paid for by Owner.
- 1. Every Application for Payment shall be accompanied by "Waiver and Release of Lien" and "Certified Payroll Reports" for Prevailing Wage.
 - 2. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment Application Times: The date for each progress payment is indicated in the Owner/Contractor Agreement. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
- C. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
 2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
 3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
- E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment for stored materials.
 2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 3. Provide summary documentation for stored materials indicating the following:
 - a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
 - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
 - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- F. Transmittal: Submit signed and notarized PDF of each Application for Payment to Architect via email or file sharing platform. Include waivers of lien, copies of certified payroll from all trades showing work completed and similar attachments, if required.
1. Transmit with a transmittal form listing attachments and recording appropriate information about application.
- G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 2. When an application shows completion of an item, submit 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.
- H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.

2. Schedule of values.
 3. Contractor's construction schedule (preliminary if not final).
 4. Products list (preliminary if not final).
 5. Schedule of unit prices.
 6. **Submittal schedule** (preliminary if not final).
 7. List of Contractor's staff assignments.
 8. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 9. Certificates of insurance and insurance policies.
 10. Performance and payment bonds.
 11. Data needed to acquire Owner's insurance.
- I. Five (5) percent retainage shall be maintained in the Application for Payments until the Certificate of Final Completion is issued.
- J. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 - a. Complete administrative actions, submittals, and Work preceding this application, as described in Section 01 77 00 "Closeout Procedures."
 2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- K. Administrative Actions and submittals that shall proceed or coincide with this application include:
1. Warranties (guarantees) and maintenance agreements.
 2. Maintenance instructions.
 3. Advice on transference of insurance coverage.
 4. List of incomplete Work recognized as exceptions to Architect's Certificate of Substantial Completion.
 5. Coordination and transfer of utilities.
- L. 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:
1. Evidence of completion of Project closeout requirements.
 2. Certification of completion of final punch list items.
 3. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 4. Updated final statement, accounting for final changes to the Contract Sum.
 5. Evidence that claims have been settled.
 6. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
 7. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
 8. State of MO PW-4 Affidavit of Compliance with Prevailing wage form completed from all trades who performed work on the project.

9. Final liquidated damages settlement statement.
10. Proof that taxes, fees, and similar obligations are paid.
11. Waivers and releases.
12. 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.
13. Operations and Maintenance data.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:
1. General coordination procedures.
 2. Coordination drawings.
 3. Request for Interpretation (RFIs).
 4. Web-based Project management software package. (Coordinate with JE Dunn)
 5. Electronic Submittal Procedures
 6. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
- C. Related Requirements:
1. Section 01 32 00 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 2. Section 01 73 00 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 3. Section 01 77 00 "Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
 2. Number and title of related Specification Section(s) covered by subcontract.
 3. Drawing number and detail references, as appropriate, covered by subcontract.

1.5 GENERAL COORDINATION PROCEDURES

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

2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
 4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- B. If necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's construction schedule.
 2. Preparation of the schedule of values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Preinstallation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.

1.6 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated 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 entity.
1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. **Do not base coordination drawings on reproductions of the Contract Documents or standard printed data.** Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - f. Indicate required installation sequences.

- g. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

1.7 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 1. RFIs shall originate with the Contractor. RFIs submitted by entities other than Contractor will be returned with no response.
 2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
 1. Project name.
 2. Name of Architect.
 3. Date.
 4. Name of Contractor.
 5. RFI number, numbered sequentially.
 6. RFI subject.
 7. Specification Section number and title and related paragraphs, as appropriate.
 8. Drawing number and detail references, as appropriate.
 9. Field dimensions and conditions, as appropriate.
 10. Contractor's suggested resolution(s). If Contractor's suggested resolution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 11. Contractor's signature.
 12. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.
 1. Attachments shall be electronic files in PDF format.
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow **seven (7) working days** for Architect's response for each RFI. RFIs received by Architect after **1:00 p.m.** will be considered as received the following working day.
 1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect of additional information.

3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 01 26 00 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within **five (5) working days** of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log biweekly, to be current at submittal of each Application for Payment . Use software log that is part of web-based Project management software. Include the following:
 1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Architect.
 4. RFI number, including RFIs that were returned without action or withdrawn.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Architect's was received.
 8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
- F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect and Construction Manager within **seven (7)** days if Contractor disagrees with response.

1.8 WEB-BASED PROJECT MANAGEMENT SOFTWARE PACKAGE

- A. Web-Based Project Management Software Package: **Provide, administer, and use** web-based Project management software package for purposes of hosting and managing Project communication and documentation until Final Completion.
 1. Web-based Project management software includes, at a minimum, the following features:
 - a. Compilation of Project data, including Contractor, subcontractors, Architect, Architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
 - b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
 - c. Document workflow planning, allowing customization of workflow between project entities.
 - d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
 - e. Track status of each Project communication in real time, and log time and date when responses are provided.
 - f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
 - g. Processing and tracking of payment applications.
 - h. Processing and tracking of contract modifications.
 - i. Creating and distributing meeting minutes.

- j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
 - k. Management of construction progress photographs.
 - l. Mobile device compatibility, including smartphones and tablets.
 - 2. Provide up to **seven** Project management software user licenses for use of Owner, Architect, and Architect's consultants. Provide **eight** hours of software training at Architect's office or via virtual meeting for web-based Project software users.
 - 3. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect. Provide data in locked format to prevent further changes.
- B. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:
- 1. Assemble complete submittal package into a single indexed file, incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 - 2. Name file with submittal number or other unique identifier, including revision identifier.
 - 3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.9 ELECTRONIC SUBMITTAL PROCEDURES

- A. General:
- 1. Shop drawing and product data submittals shall be transmitted to Architect in electronic (PDF) format using Submittal Exchange, a website service designed specifically for transmitting submittals between construction team members.
 - 2. The intent of electronic submittals is to expedite the construction process by reducing paperwork, improving information flow, and decreasing turnaround time.
 - 3. The electronic submittal process is not intended for color samples, color charts, or physical material samples.
- B. Procedures:
- 1. Submittal Preparation - Contractor may use any or all of the following options:
 - a. Subcontractors and Suppliers provide electronic (PDF) submittals to Contractor via the Submittal Exchange website.
 - b. Subcontractors and Suppliers provide paper submittals to General Contractor who electronically scans and converts to PDF format.
 - c. Subcontractors and Suppliers provide paper submittals to Scanning Service which electronically scans and converts to PDF format.
 - 2. **Contractor shall review and apply electronic stamp certifying that the submittal complies with the requirements of the Contract Documents including verification of manufacturer / product, dimensions and coordination of information with other parts of the work.**
 - 3. Contractor shall transmit each submittal to Architect using ProCore (review with JEDunn).
 - 4. Architect / Engineer review comments will be made available on the X website for downloading. Contractor will receive email notice of completed review.
 - 5. Distribution of reviewed submittals to subcontractors and suppliers is the responsibility of the Contractor.

C. Costs: Contractor shall include the full cost of Submittal Exchange project subscription in their bid.

1. At Contractor's option, training is available from Submittal Exchange regarding use of website and PDF submittals. Contact Submittal Exchange at 1-800-714-0024.
2. Internet Service and Equipment Requirements:
 - a. Email address and Internet access at Contractor's main office.
 - b. Adobe Acrobat (www.adobe.com), Bluebeam PDF Revu (www.bluebeam.com), or other similar PDF review software for applying electronic stamps and comments.

1.10 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times a minimum of **seven (7)** days prior to meeting.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within **three (3)** days of the meeting.
- B. Preconstruction Conference: Schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than **Fifteen (15) days** after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
1. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Responsibilities and personnel assignments.
 - b. Tentative construction schedule.
 - c. Phasing.
 - d. Critical work sequencing and long lead items.
 - e. Designation of key personnel and their duties.
 - f. Lines of communications.
 - g. Use of web-based Project software.
 - h. Procedures for processing field decisions and Change Orders.
 - i. Procedures for RFIs.
 - j. Procedures for testing and inspecting.
 - k. Procedures for processing Applications for Payment.
 - l. Distribution of the Contract Documents.
 - m. Submittal procedures.
 - n. Preparation of Record Documents.
 - o. Use of the premises and existing building.
 - p. Working hours.
 - q. Responsibility for temporary facilities and controls.
 - r. Procedures for disruptions and shutdowns.
 - s. Parking availability.
 - t. Office, work, and storage areas.
 - u. Equipment deliveries and priorities.
 - v. First aid.
 - w. Security.
 - x. Progress cleaning.

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other Sections and when required for coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Review of mockups.
 - i. Possible conflicts.
 - j. Compatibility requirements.
 - k. Time schedules.
 - l. Weather limitations.
 - m. Manufacturer's written instructions.
 - n. Warranty requirements.
 - o. Compatibility of materials.
 - p. Acceptability of substrates.
 - q. Temporary facilities and controls.
 - r. Space and access limitations.
 - s. Regulations of authorities having jurisdiction.
 - t. Testing and inspecting requirements.
 - u. Installation procedures.
 - v. Coordination with other work.
 - w. Required performance results.
 - x. Protection of adjacent work.
 - y. Protection of construction and personnel.
 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

- a. Preparation of Record Documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Procedures for completing and archiving web-based Project software site data files.
 - d. Submittal of written warranties.
 - e. Requirements for preparing operations and maintenance data.
 - f. Requirements for delivery of material samples, attic stock, and spare parts.
 - g. Requirements for demonstration and training.
 - h. Preparation of Contractor's punch list.
 - i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - j. Submittal procedures.
 - k. Coordination of separate contracts.
 - l. Owner's partial occupancy requirements.
 - m. Installation of Owner's furniture, fixtures, and equipment.
 - n. Responsibility for removing temporary facilities and controls.
 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Owner-Architect-Construction Manager ("OAC") Meetings: Conduct regular OAC meetings at **monthly** intervals to update on project progress and to review coordination issues. Coordinate dates of meetings with preparation of payment requests.
1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site use.
 - 8) Temporary facilities and controls.
 - 9) Progress cleaning.
 - 10) Quality and work standards.
 - 11) Status of correction of deficient items.
 - 12) Field observations.
 - 13) Status of RFIs.
 - 14) Status of Proposal Requests.
 - 15) Pending changes.
 - 16) Status of Change Orders.
 - 17) Pending claims and disputes.
 - 18) Documentation of information for payment requests.

3. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Construction Manager's construction schedule.
 - 2. Construction schedule updating reports.
 - 3. Daily construction reports.
 - 4. Site condition reports.
- B. Related Requirements:
 - 1. Section 01 29 00 "Payment Procedures" for schedule of values and requirements for use of cost-loaded schedule for Applications for Payment.
 - 2. Section 01 40 00 "Quality Requirements" for schedule of tests and inspections.

1.2 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. CPM: *Critical Path Method*, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- D. Event: The starting or ending point of an activity.
- E. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
- F. Baseline: The initial complete schedule as approved. The Baseline Schedule shall be preserved and not changed by subsequent updates.

1.3 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:

1. Working electronic copy of schedule file, where indicated.
 2. PDF electronic file.
- B. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.
- C. Construction Manager's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
- D. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 3. Total Float Report: List of all activities sorted in ascending order of total float.
 4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work until most recent Application for Payment.
- E. Construction Schedule Updating Reports: Submit with Applications for Payment.
1. Updated Schedules shall show current schedule compared to the baseline schedule in a Gantt Chart Format.
- F. Daily Construction Reports: Submit at weekly intervals.
- G. Site Condition Reports: Submit at time of discovery of differing conditions.

1.4 COORDINATION

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

PART 2 - PRODUCTS

2.1 CONSTRUCTION MANAGER'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time Frame: Extend schedule from date established for commencement of the Work or the Notice to Proceed to date of Substantial Completion and Final Completion.
1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- B. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
 2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.

3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
 4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's (and if applicable, Construction Manager's) administrative procedures necessary for certification of Substantial Completion.
 6. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.
- C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
 2. Work under More Than One Contract: Include a separate activity for each contract.
 3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 4. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.
 - d. Partial occupancy before Substantial Completion.
 - e. Use of premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.
 5. Work Stages: Indicate important stages of construction for each major portion of the Work.
- D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.
- E. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
1. Unresolved issues.
 2. Unanswered Requests for Information.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and Contract Time.
- F. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule.
- G. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's construction schedule within 30 days of date established for commencement of the Work or the Notice to Proceed.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
 1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

2.3 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

- A. General: Prepare network diagrams using AON (activity-on-node) format.

- B. Startup Network Diagram: Submit diagram within 14 days of date established for commencement of the Work or the Notice to Proceed. Outline significant construction activities for the first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.
- C. CPM Schedule: Prepare Contractor's construction schedule using a time-scaled CPM network analysis diagram for the Work.
 - 1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 60 days after date established for commencement of the Work or the Notice to Proceed.
 - a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Architect's approval of the schedule.
 - 2. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 - 3. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to coordinate with the Contract Time.
- D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.
 - 1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals.
 - b. Mobilization and demobilization.
 - c. Purchase of materials.
 - d. Delivery.
 - e. Fabrication.
 - f. Utility interruptions.
 - g. Installation.
 - h. Work by Owner that may affect or be affected by Contractor's activities.
 - i. Testing (and commissioning, if applicable).
 - j. Punch list and final completion.
 - k. Activities occurring following final completion.
 - 2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
 - 3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
 - 4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
- E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule compared to the baseline schedule.
- F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities this shall become the baseline schedule and shall not be changed during the course of the project on subsequent updates. Prepare tabulated reports showing the following:
 - 1. Contractor or subcontractor and the Work or activity.
 - 2. Description of activity.
 - 3. Main events of activity.
 - 4. Immediate preceding and succeeding activities.
 - 5. Early and late start dates.

6. Early and late finish dates.
 7. Activity duration in workdays.
 8. Total float or slack time.
 9. Average size of workforce.
 10. Dollar value of activity (coordinated with the schedule of values).
- G. Schedule Updating: Concurrent with making revisions to schedule and compared to the baseline schedule, prepare tabulated reports showing the following:
1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.
 4. Changes in activity durations in workdays.
 5. Changes in the critical path.
 6. Changes in total float or slack time.
 7. Changes in the Contract Time.

2.4 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site. Upload to project website and email owner's representative. If conditions qualifying as a weather day or other delay, notify owner within 24 hours of event.:
1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.
 4. Equipment at Project site.
 5. Material deliveries.
 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 7. Accidents.
 8. Meetings and significant decisions.
 9. Unusual events.
 10. Stoppages, delays, shortages, and losses.
 11. Meter readings and similar recordings.
 12. Emergency procedures.
 13. Orders and requests of authorities having jurisdiction.
 14. Change Orders received and implemented.
 15. Construction Change Directives received and implemented.
 16. Services connected and disconnected.
 17. Equipment or system tests and startups.
 18. Partial completions and occupancies.
 19. Substantial Completions authorized.
- B. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

PART 3 - EXECUTION

3.1 CONSTRUCTION MANAGER'S CONSTRUCTION SCHEDULE

- A. Construction Manager's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities as compared to the baseline schedule. Issue schedule one week before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate final completion percentage for each activity.

- B. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Construction Manager with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 01 32 00

SECTION 01 32 33 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Concealed Work photographs.
 - 3. Periodic construction photographs.
 - 4. Time-lapse sequence construction photographs.
- B. Related Requirements:
 - 1. Section 01 77 00 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.
 - 2. Section 01 79 00 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.
 - 3. Section 02 41 19 "Selective Demolition" for photographic documentation before selective demolition operations commence.

1.3 INFORMATIONAL SUBMITTALS

- A. Digital Photographs: Submit image files within three days of taking photographs.
 - 1. Submit photos by uploading to web-based Project management software site. Include copy of key plan indicating each photograph's location and direction.
 - 2. Identification: Provide the following information with each image description in web-based Project management software site:
 - a. Name of Project.
 - b. Date photograph was taken.
 - c. Description of location, vantage point, and direction.

1.4 QUALITY ASSURANCE

- A. Construction Webcam Service Provider: A firm specializing in providing photographic equipment, web-based software, and related services for construction projects, with a record of providing satisfactory services similar to those required for Project.

1.5 FORMATS AND MEDIA

- A. Digital Photographs: Provide color images in PDF format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels, and with vibration-reduction technology. Use flash in low light levels or backlit conditions.
- B. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
- C. File Names: Name media files with date Project area and sequential numbering suffix.

1.6 CONSTRUCTION PHOTOGRAPHS

- A. General: Take photographs with maximum depth of field and in focus.
1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- B. Preconstruction Photographs: Before **commencement of excavation** take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by **Architect**.
1. Flag **excavation areas** before taking construction photographs.
 2. Take **20** photographs to show existing conditions adjacent to property before starting the Work.
 3. Take **20** photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- C. Concealed Work Photographs: Before proceeding with installing work that will conceal other work, take photographs sufficient in number, with annotated descriptions, to record nature and location of concealed Work, including, but not limited to, the following:
1. Underground utilities.
 2. Underslab services.
 3. Piping.
 4. Electrical conduit.
 5. Waterproofing and weather-resistant barriers.
- D. Periodic Construction Photographs: Take 20 photographs weekly. Select vantage points to show status of construction and progress since last photographs were taken.
- E. Time-Lapse Sequence Construction Photographs: Take 20 photographs as indicated, to show status of construction and progress since last photographs were taken.
1. Frequency: Take photographs monthly, on the same date each month .
 2. Vantage Points: Following suggestions by Construction Manager and Contractor, photographer to select vantage points. During each of the following construction phases, take not less than two of the required shots from same vantage point each time, to create a time-lapse sequence as follows:
 - a. Commencement of the Work, through completion of subgrade construction.
 - b. Above-grade structural framing.
 - c. Exterior building enclosure.
 - d. Interior Work, through date of Substantial Completion.
 - e. .
- F. Additional Photographs: Architect or Construction Manager may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.
1. Three days' notice will be given, where feasible.
 2. In emergency situations, take additional photographs within 24 hours of request.
 3. Circumstances that could require additional photographs include, but are not limited to, the following:
 - a. Immediate follow-up when on-site events result in construction damage or losses.
 - b. Photographs are to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
 - c. Substantial Completion of a major phase or component of the Work.
 - d. Extra record photographs at time of final acceptance.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 32 33

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Submittal schedule requirements.
 - 2. Administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples.
- B. Related Requirements:
 - 1. Section 01 29 00 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
 - 2. Section 01 31 00 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
 - 3. Section 01 32 00 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 - 4. Section 01 32 33 "Photographic Documentation" for submitting preconstruction photographs, periodic construction photographs, and Final Completion construction photographs.
 - 5. Section 01 40 00 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
 - 6. Section 01 77 00 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
 - 7. Section 01 78 23 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 - 8. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires Architect's action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written information that does not require Architect's responsive action. Submittals may be rejected for not complying with requirements.

1.4 SUBMITTAL PROCEDURES

- A. General Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

- B. Submittals Schedule: Comply with requirements in Division 1 Section "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.
1. Pre-engineered Metal Building, Structural Steel, HVAC, Lighting and other major submittal packages that require consultant coordination will require additional time above and beyond the initial review time period below. The submittal schedule must be coordinated in advance with the Architect to eliminate parallel review of other submittals during major submittal review (critical path) and agreed upon an expected time frame to complete reviews. The design team cannot be held responsible to the initial review timeline in the event of a failure to coordinate submittal schedule on the contractor's part.
- C. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals. **No additional compensation will be given to the Contractor to produce revisions to the shop drawings.**
1. Initial Review: Allow **fifteen (15) days** for initial review of each basic submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: **Allow fifteen (15) days** for review of each resubmittal.
- D. Identification: Place a permanent label or title block on each submittal for identification.
1. Indicate name of firm or entity that prepared each submittal on label or title block.
 2. Provide a space approximately 4 by 5 inches on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
 3. Include the following information on label for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name and address of Contractor.
 - e. Name and address of subcontractor.
 - f. Name and address of supplier.
 - g. Name of manufacturer.
 - h. Submittal number or other unique identifier, including revision identifier.
 - i. Number and title of appropriate Specification Section.
 - j. Drawing number and detail references, as appropriate.
 - k. Location(s) where product is to be installed, as appropriate.
 - l. Other necessary identification.
- E. Deviations: Highlight, encircle, or otherwise specifically identify deviations from the Contract Documents on submittals.
- F. Additional Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
1. Additional copies submitted for maintenance manuals will be marked with action taken and will be returned.

- G. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return submittals, without review or discard submittals received from sources other than Construction Manager.

1. Transmittal Form: Use AIA Document G810 or an equivalent.

2. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.

- H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- I. Use for Construction: Use only final submittals with mark indicating action taken by Architect in connection with construction.
- J. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.
- K. Submittals Utilizing Web-Based Project Software: Prepare submittals as PDF files or other format indicated by Project management software.

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's written recommendations.
 - b. Manufacturer's product specifications.
 - c. Manufacturer's installation instructions.
 - d. Standard color charts.
 - e. Manufacturer's catalog cuts.
 - f. Wiring diagrams showing factory-installed wiring.
 - g. Printed performance curves.
 - h. Operational range diagrams.
 - i. Compliance with specified referenced standards.
 - j. Testing by recognized testing agency.
 - k. Application of testing agency labels and seals.
 - l. Notation of coordination requirements.
 4. Number of Copies: **Submit Product Data electronically**, unless otherwise indicated. Architect will return digital markups. Mark up and retain one returned copy as a Project Record Document.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Dimensions.
 - b. Identification of products.
 - c. Fabrication and installation drawings.
 - d. Roughing-in and setting diagrams.
 - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
 - f. Shopwork manufacturing instructions.
 - g. Templates and patterns.
 - h. Schedules.
 - i. Notation of coordination requirements.
 - j. Notation of dimensions established by field measurement.
 - k. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
 2. 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 40 inches.
- D. Samples: Submit Samples, as required per Specification Section for 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 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 appropriate Specification Section.
 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 one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.

2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by other Specification Sections.
1. Number of Copies: Submit electronically per Section 01 30 33, unless otherwise indicated. Architect will not return paper copies.
 2. Certificates and Certifications: Provide a notarized 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.
 3. Test and Inspection Reports: Comply with requirements specified in Division 1 Section "Quality Requirements."
- B. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of Architects and owners, and other information specified.

- C. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
- D. Installer Certificates: Prepare 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.
- E. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- F. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- G. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- H. Material Test Reports: Prepare 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.
- I. Product Test Reports: Prepare written reports indicating 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.
- J. Research/Evaluation Reports: Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
- K. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, 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.
- L. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements specified in Division 1 Section "Operation and Maintenance Data."
- M. Design Data: Prepare 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.
- N. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
- O. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
- P. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

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

3.2 ARCHITECT'S/ ACTION

- A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:
 - 1. No Exceptions Taken,
 - 2. Make Corrections Noted,
 - 3. Revise and Resubmit, or
 - 4. Rejected – See Remarks.
- C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- D. Partial submittals are not acceptable, will be considered non-responsive, and will be returned without review.
- E. 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

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and Special Inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve the Contractor of responsibility for compliance with the Contract Document requirements.

1. Owner will contract directly for the various testing and special inspection services for this project. Contractor shall cooperate, assist in coordination, and provide assistance when required for the testing service to perform their services. **Where STATE inspections might be required, the Contractor is responsible for obtaining the permits.**
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, Commissioning Authority, Construction Manager, or authorities having jurisdiction are not limited by provisions of this Section.
4. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.

1.3 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect or Construction Manager.
- C. Preconstruction 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.
- D. 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.
- E. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- F. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

- 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).
- I. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- J. Mockups: Full-size physical assemblies that are constructed on site to establish the standard by which the Work will be judged. Mockups are not Samples.
 - 1. Mockups are used for one or more of the following:
 - a. Verify selections made under Sample submittals.
 - b. Demonstrate aesthetic effects.
 - c. Demonstrate the qualities of products and workmanship.
 - d. Demonstrate successful installation of interfaces between components and systems.
 - e. Perform preconstruction testing to determine system performance.
 - 2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
 - 3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.
 - 4. Laboratory Mockups: Full-size physical assemblies constructed at testing facility to verify performance characteristics.

1.4 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated Design Services Statement: Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.5 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.

1.6 ACTION SUBMITTALS

- A. Mockup Shop Drawings:
 - 1. Include plans, sections, elevations, and details, indicating materials and size of mockup construction.
 - 2. Indicate manufacturer and model number of individual components.
 - 3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.7 INFORMATIONAL SUBMITTALS

- A. Contractor'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 submitted to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
 - 2. Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- 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.
- F. Reports: Prepare and submit certified written reports and documents as specified.
- G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

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

1.9 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

- H. Manufacturer's Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor's responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - d. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups; do not reuse products on Project.
- J. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect and Commissioning Authority, through Construction Manager, with copy to Contractor. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
- K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Build mockups of size indicated.
 - 2. Build mockups in location indicated or, if not indicated, as directed by Architect.
 - 3. Notify Architect **seven** days in advance of dates and times when mockups will be constructed.
 - 4. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
 - 5. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 6. Obtain Architect's approval of mockups before starting corresponding Work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 - 7. Promptly correct unsatisfactory conditions noted by Architect's preliminary review, to the satisfaction of the Architect, before completion of final mockup.
 - 8. Approval of mockups by the Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work. Location must allow for integrated assembly mockup to remain in place for review prior to beginning exterior assemblies and remain until after actual work is installed and confirmed to meet standard of workmanship and aesthetics set by the mockup
 - 10. Demolish and remove mockups when directed unless otherwise indicated.
- L. Specialty Mockups: See Section 01 43 39 "Mockups" for additional construction requirements for integrated exterior mockups.
- M. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Specification Sections in Divisions 02 through 33.

1.10 QUALITY CONTROL

- A. Contractor Responsibilities: Tests and inspections are the Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
 - 1. Engage a qualified testing agency to perform these quality-control services.
 - 2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 - 3. Submit a certified written report, in duplicate, of each quality-control service.
 - 4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 - 5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- B. Manufacturer's Field Services: Where indicated, engage a manufacturer's representative to observe and inspect the Work. Manufacturer's representative's services include examination of substrates and conditions, verification of materials, inspection of completed portions of the Work, and submittal of written reports.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- D. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 - 1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 - 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 - 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 - 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 - 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 - 6. Do not perform any duties of Contractor.
- E. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - 1. Access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 - 4. Facilities for storage and field curing of test samples.
 - 5. Delivery of samples to testing agencies.
 - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 - 7. Security and protection for samples and for testing and inspecting equipment at Project site.

- F. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.11 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: **The owner will provide special inspections and testing to be conducted by a qualified third-party testing agency; as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:**

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews the completeness and adequacy of those procedures to perform the Work.
2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Architect.
 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching.
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Construction Manager's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00

SECTION 01 42 00 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

- A. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- B. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "approved," "required," and "permitted" have the same meaning as "directed."
- C. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- D. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- E. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- F. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- G. "Provide": Furnish and install, complete and ready for the intended use.
- H. "Installer": Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to trades people of the corresponding generic name.
- I. "Experienced": When used with an entity, "experienced" means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- J. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the

Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.
- C. Conflicting Requirements:
 - 1. If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.
 - a. 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 or requirements. Refer uncertainties to Architect for a decision before proceeding.
 - 2. In the event of a conflict within the Contract Documents, it will be assumed that the greater quality or greater quantity of the two is intended.
- D. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
 - 1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.
- E. Abbreviations and Acronyms for Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 00

SECTION 01 43 39 - MOCKUPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Integrated exterior mockups.
- B. Related Requirements:
 - 1. Section 01 40 00 "Quality Requirements" for quality assurance requirements for aesthetic and workmanship mockups specified in other Sections.

1.3 DEFINITIONS

- A. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as **freestanding temporary built elements**, consisting of multiple products, assemblies, and subassemblies.
- B. Integrated Interior Mockups: Mockups of interior element(s) constructed on-site as freestanding temporary built elements, consisting of multiple products, assemblies, and subassemblies.
- C. Mockups are not Samples.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site .
 - 1. Meet with Owner, Construction Manager, Architect, testing and inspecting agency representative, and installers of major systems whose Work is included in integrated exterior mockups.
 - 2. Review coordination of equipment and furnishings provided by the Owner for room mockups.
 - 3. Review locations and extent of mockups.
 - 4. Review testing procedures to be performed on mockups.
 - 5. Review and finalize schedule for mockups, and verify availability of materials, personnel, equipment, and facilities needed to complete mockups and testing and maintain schedule for the Work.

1.5 ACTION SUBMITTALS

- A. Shop Drawings: For integrated exterior / interior mockups.
 - 1. Include plans, elevations, sections, and **mounting and support** details.
 - 2. Indicate manufacturer and model number of individual components, subassemblies, and assemblies.
 - 3. Include site location drawing indicating orientation of mockup.

4. Revise and resubmit Shop Drawings to reflect approved modifications in details and component interfaces resulting from changes made during testing procedures.
- B. Delegated Design Submittal: For temporary structural supports for mockups not attached to building structure, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 QUALITY ASSURANCE

- A. Build mockups to do the following:
 1. Verify selections made under Sample submittals.
 2. Demonstrate aesthetic effects.
 3. Demonstrate the qualities of products and workmanship.
 4. Demonstrate acceptable coordination between components and systems.
- B. Fabrication: Before fabricating or installing portions of the Work requiring mockups, build mockups for each form of construction and finish required. Use materials and installation methods as required for the Work.
 1. Build mockups of size and extent to be defined by Owner and Architect.
 2. Build mockups in location to be established by Owner and Architect.
 3. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 6. Demolish and remove mockups when directed unless otherwise indicated.
- C. Notifications:
 1. Notify Architect **seven (7) days** in advance of the dates and times when mockups will be constructed.
 2. Notify Architect **fourteen (14) days** in advance of the dates and times when mockups will be tested.
 3. Allow **seven (7) days** for initial review and each re-review of each mockup.
- D. Approval: Obtain Architect's approval of mockups before starting fabrication or construction of corresponding Work.
 1. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 COORDINATION

- A. Coordinate schedule for construction of mockups, so construction, testing, and review of mockups do not impact Project schedule.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer to design support structure for free-standing mockups.

2.2 FREE STANDING MOCKUP

- A. Construct integrated free standing mockups **according to approved mockup Shop Drawings**. Construct mockups to demonstrate constructability, coordination of trades, and sequencing of Work; and to ensure materials, components, subassemblies, assemblies, and interfaces integrate into a system complying with indicated performance and aesthetic requirements.
- B. Design and construct foundation and superstructure to support free-standing integrated exterior mockups.
- C. Build freestanding exterior mockups using installers and construction methods that will be used in completed construction. Contractor and Subcontractor to verify coordination / transitions between trades to test and verify in place work strategies.
 - 1. Review onsite with Architect and Trades executing work on a regular basis. Make alterations and revisions as directed until final installation methods demonstrated meet expectations for sub trades and Architect. Document alterations and revisions via shop drawings and change requests as appropriate.
- D. Use specified products that have been approved by the Architect. Coordinate installation of materials and products specified in individual Specification Sections that include Work included in integrated exterior mockups.
- E. Exterior Wall: Build mockups of exterior wall assembly incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
 - 1. Coordinate construction of mockups to permit inspection and testing of air barrier before external insulation and cladding are installed.
 - 2. Include junction with roofing membrane, **building corner condition**, and transition with fluid applied waterproofing.
 - 3. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
 - 4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- F. The Work of temporary freestanding exterior mockups includes, but is not limited to, the following:
 - 1. Architectural Concrete Unit Masonry
 - 2. Stone Masonry
 - 3. Cold-formed Metal Framing
 - 4. Rough Carpentry
 - 5. Gyp Sheathing
 - 6. Thermal insulation.
 - 7. Fluid applied membrane air barrier.
 - 8. Metal Wall & Soffit Panels
 - 9. Wood Rainscreen
 - 10. Exterior High Pressure Laminated Composite Panels
 - 11. Sheet metal flashing and trim.
 - 12. Joint sealants.

13. Glazed curtain walls (including extruded silicone AVB transition flashing).
 14. Glazing (exterior insulated glass types).
- G. Interior Resinous Matrix Terrazzo Flooring: Provide a test area for evaluation of surface preparation, control and expansion joints, high tolerance floor finish application workmanship, color, sheen, slip resistance and water resistance.
1. Provide test area for each finish specified.
 2. Review manufacturer's product data sheets to determine the suitability of each product for the specified surface.
 3. Apply as stated under Execution in this specification. Any variation from the specification must be approved by the Architect.
 4. Test area shall be a minimum of 100 square feet or 1 percent of horizontal surface to be constructed and treated in location designated by Architect.
- H. Interior Polished Concrete Floor: Provide a test area for evaluation of slab placement, surface preparation, control and expansion joints, high tolerance floor finish application workmanship, color, sheen, slip resistance and water resistance.
1. Provide test area for each finish specified.
 2. Review manufacturer's product data sheets to determine the suitability of each product for the specified surface.
 3. Apply as stated under Execution in this specification. Any variation from the specification must be approved by the Architect.
 4. Test area shall be a minimum of 100 square feet or 1 percent of horizontal surface to be constructed and treated in location designated by Architect.
 5. Test area will comply with 1.4 "Performance Guidelines" in section 03 35 43 "Polished Concrete Finishing".
 6. Test area shall be divided into four quadrants.
 7. Conduct five sets of tests composed of 4 tests each per quadrant with one test in the center. Each set of tests is composed of: 1-Gloss, 1-Rilem, 1-Hardness and 2-Slip Resistance. (See 1.4 of this specification for Performance Criteria.)
- I. Cast in place architectural concrete formed-surface panel, build mockups to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
 2. Before casting the mock-up, submit full detailed Shop Drawings of the mock-up formwork for review by the Architect. Perform all necessary preliminary tests to ensure that concrete used for the mock-up will exactly match the approved sample in color and texture.
 3. Build mockups of typical cast in place architectural concrete panels as shown on Drawings.
 4. Build panel approximately 100 sq. ft. for formed surface in the location indicated or, if not indicated, as directed by Architect.
 5. Demonstrate curing, cleaning, and protecting of cast-in-place architectural concrete, finishes, and contraction joints, as applicable.
 6. In presence of Architect, damage part of the exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.

7. The completed mock-up shall be inspected and approved by the Architect. Failure of the mock-up to match the approved sample will require the construction of further mock-ups until approval is obtained. Remove rejected mock-ups immediately
 8. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- J. Photographic Documentation: Document construction of integrated exterior mockups with photographs in accordance with Section 01 32 33 "Photographic Documentation." Provide photographs showing details of interface of different materials and assemblies.
1. Document testing procedures, including water leakage and other deficiencies. Photograph modifications to component interfaces intended to correct deficiencies.
- K. Provide and document modifications to construction details and interfaces between components and systems required to properly sequence the Work, or to pass performance testing requirements. Obtain Architect's approval for modifications.
- L. Retain approved mockups constructed in place. Incorporate fully into the Work.
- M. See other Sections for mock-up requires that pertain to the requirements under the individual Sections.

PART 3 - EXECUTION

3.1 REVIEW OF MOCKUPS

- A. Maintain mockup as benchmark for quality and craft of final installation of in place work. Verify in place work maintains quality of details, textures, craft, installation, colors verified with Owner and Architect and Subcontractors during mockup construction and review.

END OF SECTION 01 43 39

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
 - 1. Related Requirements:
 - a. Section 01 10 00 "Summary" for work restrictions and limitations on utility interruptions.

1.3 DEFINITIONS

- A. Permanent Enclosure: As determined by Architect, permanent or temporary roofing is complete, insulated, and weathertight; exterior walls are insulated and weathertight; and all openings are closed with permanent construction or substantial temporary closures.

1.4 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's representatives, Architect, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: Pay sewer-service use charges for sewer usage by all entities for construction operations.
- C. Water Service: Pay water-service use charges for water used by all entities for construction operations.
- D. Electric Power Service: Pay electric-power-service use charges for electricity used by all entities for construction operations.

1.5 INFORMATIONAL SUBMITTALS

- A. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
 - 1. Locations of dust-control partitions at each phase of work.
 - 2. HVAC system isolation schematic drawing.
 - 3. Location of proposed air-filtration system discharge.
 - 4. Waste-handling procedures.
 - 5. Other dust-control measures.

1.6 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines.

1.7 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 TEMPORARY FACILITIES

- A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:
 - 1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
 - 2. Conference room of sufficient size to accommodate meetings of **10** individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- (1.2-m-) square tack and marker boards.
 - 3. Drinking water.
 - 4. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
 - 5. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.
- C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 - 1. Store combustible materials apart from building.
- D. Portable Chain-Link Fencing: Minimum 2 inch (50 mm), 0.148 inch (3.8 mm) thick, galvanized steel, chain-link fabric fencing; minimum 8 feet (1.8 m) high with galvanized steel pipe posts; minimum 2-3/8 inch (60 mm) OD line posts and 2-7/8 inch (73 mm) OD corner and pull posts, with 1-5/8 inch (42 mm) OD top and bottom rails. Provide galvanized steel bases for supporting posts.
- E. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain link fence, sized to height of fence, in color selected by Architect from manufacturer's standard colors.
- F. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats minimum 36 by 60 inches (914 by 1524 mm).
- G. Temporary Toilet Units: Provide self-contained single-occupant toilet units of the chemical, aerated recirculation, or combustion type, properly vented and fully enclosed with a glass fiber reinforced polyester shell or similar nonabsorbent material. Shield toilets to ensure privacy. Use of pit type privies will not be permitted. Do not use plumbing lines for disposal or flushing of construction residues or debris. Contractor or Sub-contractor employees shall not use toilets in any portion of the building.
- H. Drinking Water Facilities: Provide containerized tap-dispenser bottled-water type drinking water units, including paper supply, or other approved sanitary drinking water service.

2.2 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
 - 3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 01 77 00 "Closeout Procedures."

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Locate facilities within the construction limits as indicated on Drawings and where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
 - 1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
 - 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Toilets: Use of Owner's existing toilet facilities will NOT be permitted.
- E. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.
- F. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
 1. Prior to commencing work, isolate the HVAC system in area where work is to be performed.
 - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
 - b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- G. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
 1. Install electric power service overhead unless otherwise indicated.
- H. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- I. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install WiFi cell phone access equipment or land-based telephone line(s) for each field office.

3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
 1. Provide incombustible construction for offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
 2. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. **Project Identification and Temporary Signs:** Provide Project identification and other signs, including, but not limited to, a 4'-0" x 8'-0" project sign, mesh banner. Banner shall be mounted to project fence, be hemmed on all sides, and have metal grommets. Coordinate information to be included on project sign with Architect prior to fabrication. Unauthorized signs are not permitted.
- C. Temporary lay down areas: Construct and maintain temporary gravel areas adequate for construction operations. Locate gravel areas **within construction limits indicated** on Drawings.
 1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- D. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas as indicated within construction limits indicated on Drawings.

1. Provide dust-control treatment that is nonpolluting and non-tracking. Reapply treatment as required to minimize dust.
- E. Traffic Controls: Comply with requirements of authorities having jurisdiction.
 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- F. Parking: Provide temporary parking areas for construction personnel **within construction limits indicated** on the Drawings. Parking is prohibited in in any school parking areas, bus pick up/drop off, and unauthorized areas. The staging area and all areas for material storage will be limited on site as designated by the owner prior to the start of construction.
- G. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 2. Remove snow and ice as required to minimize accumulations.
- H. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with Section 01 74 19 "Construction Waste Management and Disposal" and with progress cleaning requirements in Section 01 73 00 "Execution."

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
 1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
 1. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- C. Temporary Erosion and Sedimentation Control:
 1. Comply with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Section 31 10 00 "Site Clearing."
 2. Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, in accordance with erosion- and sedimentation-control Drawings and requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
 - a. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
 - b. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 - c. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 - d. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

- E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- F. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals, so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.
- G. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
 - 1. Extent of Fence: As required to enclose entire Project site **or portion determined sufficient to accommodate construction operations.**
 - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide Owner with one set of keys.
 - 3. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.
- H. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.
- I. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- J. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- K. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.
 - 1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
 - 2. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 - 3. Protect air-handling equipment.
 - 4. Provide walk-off mats at each entrance through temporary partition.
- L. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
 - 1. Prohibit smoking in construction areas.
 - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 - 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

3.5 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 3. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 00 "Closeout Procedures."

END OF SECTION 01 50 00

SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.

1.3 DEFINITIONS

- A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. **Substitutions must be approved by the Architect and shall only be considered for approved prior to bidding the project or at Architect's discretion after bidding.**
- C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.
- D. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.
- E. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:
1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.

2. Data indicating compliance with the requirements specified in Part 2 "Comparable Products" Article.
- F. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 01 33 00 "Submittal Procedures."
- G. Substitution: Refer to Section 01 25 00 "Substitution Procedures" for definition and limitations on substitutions.

1.4 QUALITY ASSURANCE

- A. Compatibility of Options: If Construction Manager is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.5 COORDINATION

- A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written 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 ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
- C. Storage:
 1. Store products to allow for inspection and measurement of quantity or counting of units.
 2. Store materials in a manner that will not endanger Project structure.
 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 4. Store cementitious products and materials on elevated platforms.
 5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.

7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Construction Manager of obligations under requirements of the Contract Documents.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
 3. Refer to Divisions 2 through 16 Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 01 77 00 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that 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.
 5. Where products are accompanied by the term "match sample," sample to be matched is Architect's.
 6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
 7. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in Part 2 "Comparable Products" Article to obtain approval for use of an unnamed product.

- a. Submit additional documentation required by Architect through in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by the Architect, whose determination is final.

B. Product Selection Procedures:

1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
3. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
5. Available Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
6. Available Manufacturers: Where Specifications include a list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
7. Basis-of-Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product by the other named manufacturers.
8. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
 - a. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.
9. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product that complies with other specified requirements.
 - a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
 - b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 PRODUCT SUBSTITUTIONS

- A. Timing: **Architect will consider requests for substitution only during bidding period.** Requests received after that time may be considered or rejected at discretion of Architect.
- B. Refer to Section 01 25 00 "Substitution Procedures" for substitution request requirements.

2.3 COMPARABLE PRODUCTS

- A. Conditions: Architect will consider Construction Manager's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - 1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 - 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 - 3. Evidence that proposed product provides specified warranty.
 - 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 - 5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00

SECTION 01 65 00 – REQUEST FOR SUBSTITUTION DURING BIDDING

Requests proposed by the Contractor during bidding for changes in products, materials or equipment required by Contract Documents are considered "Requests for Substitution." Fill out the following as appropriate and submit to the Architect for review at least **five days prior to the Bid Date**. No substitution will be reviewed without submittal of the form.

SPEC. SECTION _____ **PAGES:** _____ **LINE #:** _____
DRAWING SHEET # _____ **DETAIL #** _____

SPECIFIED PRODUCT, MATERIALS OR EQUIPMENT:

PROPOSED SUBSTITUTION:

PROVIDE THE FOLLOWING DOCUMENTATION AND OTHER INFORMATION AS APPROPRIATE TO INDICATE COMPLIANCE WITH REQUIREMENTS FOR THE SUBSTITUTIONS:

- Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
- For products that are part of a listed assembly, submit test # and request for all products in assembly affected or provide written confirmation of compatibility with other products as currently specified.
- Samples.
- A detailed comparison of significant qualities of the proposed substitution with those specified.
- A list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors, that will be necessary to accommodate the proposed substitution.
- A statement indicating the substitution's possible effect on the Construction Schedule compared to the schedule without approval of the substitution.

CHECK WHETHER THE SUBSTITUTION CHANGES OR AFFECTS THE FOLLOWING:

☐ Performance Requirements. Describe:

☐ Quality Assurance Requirements. Describe:

☐ Warranty Requirements. Describe:

☐ Products, Materials or Equipment. Describe:

☐ Drawing dimensions, elevation, sections, etc. Describe:

Attach any other information, samples, etc. to help in the evaluation of the Request for Substitution During Bidding.

The undersigned hereby certifies that the substitution has been fully checked and coordinated with the Contract Documents, that the substitution is equal to or better in every aspect to that required by Contract Documents and that it will perform adequately in application indicated:

SIGNATURE: _____

FIRM NAME: _____

ADDRESS: _____

PHONE: _____

FAX: _____

The following will be completed by Dake Wells Architecture:

SUBSTITUTION ACCEPTED: ☐ Yes ☐ No

REMARKS:

REVIEWER:

END OF SECTION 01 65 00

SECTION 01 73 00 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
 - 1. Before construction, verify the location and points of connection of utility services.
- B. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning site work, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; and underground electrical services.
 - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- C. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
2. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
3. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
4. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.
- B. General: Engage a land surveyor or professional engineer to lay out the Work using accepted surveying practices.
 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 3. Inform installers of lines and levels to which they must comply.
 4. Check the location, level and plumb, of every major element as the Work progresses.
 5. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
 6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey

markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

- A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- B. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
 - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
 - 4. Maintain minimum headroom clearance of 8 feet in spaces without a suspended ceiling.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

- F. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 - 2. Allow for building movement, including thermal expansion and contraction.
- G. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- H. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
 - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 - 2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F.
 - 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 - 1. Remove liquid spills promptly.
 - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

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

3.7 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.8 PROTECTION OF INSTALLED CONSTRUCTION

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

3.9 CORRECTION OF THE WORK

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

END OF SECTION 01 73 00

SECTION 01 74 00 - WARRANTIES

PART 1 - GENERAL

1.1 GENERAL

- A. Standard product warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
- B. Special warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.
 - 1. **Refer to the General Conditions for terms of the Contractor's period for correction of the Work.**
- C. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products. Manufacturer's disclaimers and limitations on product warranties do not relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
- D. Related Damages and Losses: When correcting failed or damaged warranted construction, remove and replace construction that has been damaged as a result of such failure or must be removed and replaced to provide access for correction of warranted construction.
- E. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- F. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of the Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- G. Owner's Recourse: Expressed warranties made to the Owner are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under the law. Expressed warranty periods shall not be interpreted as limitations on the time in which the Owner can enforce such other duties, obligations, rights, or remedies.
 - 1. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 - 2. Where the Contract Documents require a special warranty, or similar commitment, the Owner reserves the right to refuse to accept the Work, until the Contractor presents evidence that entities required to countersign such commitments are willing to do so.
- H. Submit written warranties to the Architect prior to the date certified for Substantial Completion. If the Architect's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion, submit written warranties upon request of the Architect.
 - 1. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Architect within 15 days of completion of that designated portion of the Work.
- I. When the Contract Documents require the Contractor, or the Contractor and a subcontractor, supplier or manufacturer to execute a special warranty, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner, through the Architect, for approval prior to final execution.
 - 1. Refer to Divisions 02 through 33 Divisions for specific content requirements and particular requirements for submitting special warranties.

- J. Submit warranties as required in Section 01 77 00, Closeout Procedures.

1.2 PRODUCTS (Not Applicable)

1.3 EXECUTION

- A. General Contractors Warranty: The General Contractor shall provide the Owner with a minimum one year warranty on the entire project in addition to specific warranties. Warranty period shall begin at time of Substantial Completion; except that for punch list items, and/or items not deemed complete or properly functioning as intended, the warranty shall begin from the point the Owner/Architect accepts the item as complete.
- B. Start of Warranty Period: All warranties shall start upon the date of Substantial Completion. Should the project include phased work or partial areas of Substantial Completion, the warranties for the products and work of that phase or partial area take affect upon the date of Substantial Completion of that area.
- C. Schedule: Provide warranties on products and installations not specifically mentioned in this section but included in Divisions 02-33 of the specifications.

END OF SECTION 01 74 00

SECTION 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous demolition and construction waste.
 - 2. Recycling nonhazardous demolition and construction waste.
 - 3. Disposing of nonhazardous demolition and construction waste.
- B. Related Requirements:
 - 1. Section 04 20 00 "Unit Masonry" for disposal requirements for masonry waste.
 - 2. Section 31 10 00 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

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

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan **within 30 days** of date established for the Notice to Proceed.

1.6 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in tons.
4. Quantity of waste salvaged, both estimated and actual in tons.
5. Quantity of waste recycled, both estimated and actual in tons.
6. Total quantity of waste recovered (salvaged plus recycled) in tons.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

B. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of each contractor and waste management coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of demolition site-clearing and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work in compliance with local, state and/or federal requirements.
2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.

3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.
- D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there were no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Include the following:
1. Total quantity of waste.
 2. Estimated cost of disposal (cost per unit). Include transportation and tipping fees and cost of collection containers and handling for each type of waste.
 3. Total cost of disposal (with no waste management).
 4. Revenue from salvaged materials.
 5. Revenue from recycled materials.
 6. Savings in transportation and tipping fees by donating materials.
 7. Savings in transportation and tipping fees that are avoided.
 8. Handling and transportation costs. Include cost of collection containers for each type of waste.
 9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling of a minimum of **50 percent** by weight of total nonhazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:
1. Demolition Waste:
 - a. Land-clearing debris.
 - b. Asphalt paving.
 - c. Concrete.
 - d. Concrete reinforcing steel.
 - e. Brick
 - f. Concrete masonry units.
 - g. Electrical conduit.
 - h. Lighting fixtures.
 - i. Plywood and oriented strand board.
 - j. Wood trim.
 - k. Structural and miscellaneous steel.
 - l. Doors and frames.
 - m. Door hardware.
 - n. Windows.
 - o. Metal studs.
 - p. Gypsum board.
 - q. Carpet.
 - r. Carpet pad.
 - s. Equipment.
 - t. Cabinets.
 - u. Mechanical equipment.
 - v. Copper wiring.

- w. Lighting fixtures.
- x. Lamps.
- y. Ballasts.
- 2. Construction Waste:
 - a. Masonry and CMU.
 - b. Lumber.
 - c. Wood sheet materials.
 - d. Wood trim.
 - e. Metals.
 - f. Carpet and pad.
 - g. Gypsum board.
 - h. Piping.
 - i. Electrical conduit.
 - j. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:
 - 1) Paper.
 - 2) Cardboard.
 - 3) Boxes.
 - 4) Polystyrene packaging.
 - 5) Wood crates.
 - 6) Wood pallets.
 - 7) Plastic pails.
 - k. Construction Office Waste: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle **100 percent** of the following construction office waste materials:
 - 1) Paper.
 - 2) Cardboard.
 - 3) Aluminum cans.
 - 4) Glass containers.
 - 5) Plastic containers.

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 - 1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."
- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
 - 1. Distribute waste management plan to everyone concerned **within three days** of submittal return.
 - 2. Distribute waste management plan to entities **when they first begin work on-site**. Review plan procedures and locations established for salvage, recycling, and disposal.
- D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.

2. Comply with Section 01 50 00 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

- A. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:
 1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 3. Store items in a secure area until installation.
 4. Protect items from damage during transport and storage.
 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- B. Salvaged Items for Sale and Donation: Not permitted on Project site.
- C. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:
 1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area designated by Owner.
 5. Protect items from damage during transport and storage.
- D. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.
- E. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
- F. Plumbing Fixtures: Separate by type and size.
- G. Lighting Fixtures: Separate lamps by type and protect from breakage.
- H. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall be shared equally by Owner and Contractor.
- C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

- D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
 - 1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
 - 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
 - 4. Store components off the ground and protect from the weather.

3.4 RECYCLING DEMOLITION WASTE

- A. Green Waste (Landclearing) Recycling
 - 1. Green waste, such as trees, plants, and brush, removed as a result of selective demolition shall be recycled by delivery to established compost facilities. Contractor shall maintain records, including weight tickets, of all recycled green waste loads and provide a compilation of tons of green waste recycled upon project completion.
- B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.
- C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
 - 1. Pulverize concrete to maximum 1-1/2-inch size.
 - 2. Crush concrete and screen to comply with requirements in Section 312000 "Earth Moving" for use as satisfactory soil for fill or subbase.
- D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
 - 1. Pulverize masonry to maximum 3/4-inch size.
 - a. Crush masonry and screen to comply with requirements in Section 312000 "Earth Moving" for use as general fill .
 - b. Crush masonry and screen to comply with requirements in Section 329300 "Plants" for use as mineral mulch.
 - 2. Clean and stack undamaged, whole masonry units on wood pallets.
- E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- F. Metals: Separate metals by type.
 - 1. Structural Steel: Stack members according to size, type of member, and length.
 - 2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
- G. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.

- H. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
- I. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
- J. Metal Suspension System: Separate metal members, including trim and other metals from acoustical panels and tile, and sort with other metals.
- K. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
 - 1. Store clean, dry carpet and pad in a closed container or trailer provided by carpet reclamation agency or carpet recycler.
- L. Carpet Tile: Remove debris, trash, and adhesive.
 - 1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by carpet reclamation agency or carpet recycler.
- M. Piping: Reduce piping to straight lengths and store by material and size. Separate supports, hangers, valves, sprinklers, and other components by material and size.
- N. Conduit: Reduce conduit to straight lengths and store by material and size.
- O. Lamps: Separate lamps by type and store according to requirements in 40 CFR 273.

3.5 RECYCLING CONSTRUCTION WASTE

- A. Packaging:
 - 1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 - 2. Polystyrene Packaging: Separate and bag materials.
 - 3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
 - 4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
- B. Scrap Metal Recycling: Separate metals by type.
 - 1. Scrap metal, such as fencing and old reinforcement bar, removed as a result of selective demolition shall be recycled at established metal recycling facilities. Candidate facilities are listed below, but do not represent an endorsement. Contractor may propose alternative facilities.
 - 2. Contractor shall maintain records, including weight tickets, of all recycled metal loads and provide a compilation of tons of scrap metal recycled upon project completion.
- C. Wood Materials:
 - 1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
 - 2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
 - a. Comply with requirements in Section 329300 "Plants" for use of clean sawdust as organic mulch.
- D. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.
 - a. Comply with requirements in Section 329300 "Plants" for use of clean ground gypsum board as inorganic soil amendment.

E. Paint: Seal containers and store by type.

3.6 DISPOSAL OF WASTE

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

END OF SECTION 01 74 19

SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final Completion procedures.
 - 3. List of incomplete items.
 - 4. Submittal of Project warranties.
 - 5. Final cleaning.
- B. Related Requirements:
 - 1. Section 01 29 00 "Payment Procedures" for requirements for Applications for Payment for Substantial Completion and Final Completion.
 - 2. Section 01 78 23 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
 - 3. Section 01 78 39 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 4. Section 01 79 00 "Demonstration and Training" for requirements to train Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.3 DEFINITIONS

- A. List of Incomplete Items: Contractor-prepared list of items to be completed or corrected, prepared for the Architect's use prior to Architect's inspection, to determine if the Work is substantially complete.

1.4 ACTION SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

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

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1.7 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of **10 days** prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Construction Manager. Label with manufacturer's name and model number.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Construction Manager's signature for receipt of submittals.
 5. Submit testing, adjusting, and balancing records.
 6. Submit sustainable design submittals not previously submitted.
 7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of **10 days** prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Advise Owner of pending insurance changeover requirements.
 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 3. Complete startup and testing of systems and equipment.
 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 01 79 00 "Demonstration and Training."
 6. Advise Owner of changeover in utility services.

7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 9. Complete final cleaning requirements.
 10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of **10 days** prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for Final Completion.

1.8 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:
1. Submit a final Application for Payment in accordance with Section 01 29 00 "Payment Procedures."
 2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list will state that each item has been completed or otherwise resolved for acceptance.
 3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Submit pest-control final inspection report.
 5. Submit Final Completion photographic documentation.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of **10 days** prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.9 LIST OF INCOMPLETE ITEMS

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor, listed by room or space number.

2. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect and Construction Manager.
 - d. Name of Contractor.
 - e. Page number.
4. Submit list of incomplete items in the following format:
 - a. MS Excel Electronic File: Architect, through Construction Manager, will return annotated file.
 - b. PDF Electronic File: Architect, through Construction Manager, will return annotated file.
 - c. Web-Based Project Software Upload: Utilize software feature for creating and updating list of incomplete items (punch list).

1.10 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Partial Occupancy: Submit properly executed warranties within **15 days** of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- D. Provide additional copies of each warranty to include in operation and maintenance manuals.
- E. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
 1. Submit on digital media acceptable to Architect.
- F. Warranties in Paper Form:
 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- G. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - g. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - h. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
 - i. Clean flooring, removing debris, dirt, and staining; clean in accordance with manufacturer's instructions.
 - j. Vacuum and mop concrete.
 - k. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean in accordance with manufacturer's instructions if visible soil or stains remain.
 - l. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - m. Remove labels that are not permanent.
 - n. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.

- p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - q. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
 - 1) Clean HVAC system in compliance with NADCA ACR. Provide written report on completion of cleaning.
 - r. Leave Project clean and ready for occupancy.
- B. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.
- C. Pest Control: Comply with pest control requirements in Section 01 50 00 "Temporary Facilities and Controls." Prepare written report.
- D. Construction Waste Disposal: Comply with waste-disposal requirements in Section 01 74 19 "Construction Waste Management and Disposal."

END OF SECTION 01 77 00

SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory manuals.
 - 2. Systems and equipment operation manuals.
 - 3. Systems and equipment maintenance manuals.
 - 4. Product maintenance manuals.
- B. Related Requirements:
 - 1. Section 01 33 00 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

1.3 DEFINITIONS

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

1.4 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect and Engineer will comment on whether content of operation and maintenance submittals is acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
 - 1. Submit on digital media acceptable to Architect and by uploading to web-based project software site. Enable reviewer comments on draft submittals.
- C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training.
- D. Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.

2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 1. Title page.
 2. Table of contents.
 3. Manual contents.
- B. Title Page: Include the following information:
 1. Subject matter included in manual.
 2. Name and address of Project.
 3. Name and address of Owner.
 4. Date of submittal.
 5. Name and contact information for Contractor.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
 1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
 4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

- a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.7 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
 - 1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
 - 2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
 - 3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.8 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
 - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 - 2. Performance and design criteria if Contractor has delegated design responsibility.
 - 3. Operating standards.
 - 4. Operating procedures.
 - 5. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
 - 1. Product name and model number. Use designations for products indicated on Contract Documents.
 - 2. Manufacturer's name.
 - 3. Equipment identification with serial number of each component.
 - 4. Equipment function.
 - 5. Operating characteristics.
- D. Operating Procedures: Include the following, as applicable:
 - 1. Startup procedures.
 - 2. Routine and normal operating instructions.
 - 3. Normal shutdown instructions.

4. Seasonal and weekend operating instructions.
 5. Required sequences for electric or electronic systems.
- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.9 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.
- C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 3. Identification and nomenclature of parts and components.
 4. List of items recommended to be stocked as spare parts.
- E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 5. Aligning, adjusting, and checking instructions.
 6. Demonstration and training video recording, if available.

- F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.
- J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of maintenance manuals.

1.10 PRODUCT MAINTENANCE MANUALS

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 78 23

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
 - 4. Record Samples.
- B. Related Sections include the following:
 - 1. Section 00 70 00 "General Conditions".
 - 2. Section 01 73 00 "Execution" for final property survey.
 - 3. Section 01 77 00 "Closeout Procedures" for general closeout procedures.
 - 4. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 5. Divisions 2 through 16 Sections for specific requirements for Project Record Documents of the Work in those Sections.

1.3 CLOEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one (1) set of marked-up Record Prints.
- B. Record Specifications: Submit one (1) copy of Project's Specifications, including addenda and contract modifications, of those sections that have undergone changes during construction.
- C. Record Product Data: Submit one (1) copy of each Product Data submittal.
 - 1. Where Record Product Data is required as part of operation and maintenance manuals, submit marked-up Product Data as an insert in manual instead of submittal as Record Product Data.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of blue- or black-line white prints of the Contract Drawings and Shop Drawings.
 - 1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
 - a. Give particular attention to information on concealed elements that would be difficult to

- identify or measure and record later.
 - b. Accurately record information in an understandable drawing technique.
 - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
1. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Locations and depths of underground utilities.
 - d. Revisions to routing of piping and conduits.
 - e. Revisions to electrical circuitry.
 - f. Locations of concealed internal utilities.
 - g. Changes made by Change Order or Construction Change Directive.
 - h. Changes made following Architect's written orders.
 - i. Details not on the original Contract Drawings.
 - j. Field records for variable and concealed conditions.
 - k. Record information on the Work that is shown only schematically.
 2. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
 3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 4. Mark important additional information that was either shown schematically or omitted from original Drawings.
 5. Note Construction Change Directive numbers, alternate numbers, addendum numbers, Change Order numbers, and similar identification, where applicable.

2.2 RECORD SPECIFICATIONS

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

2.3 RECORD PRODUCT DATA

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

2. Note related Change Orders, Record Specifications, and Record Drawings where applicable.

2.4 RECORD SAMPLES

- A. Immediately prior to date of Substantial Completion, the Contractor shall meet with the Owner at the site to determine which of the Samples maintained during the construction period shall be transmitted to the Owner for record purposes. Comply with the Owner's instructions for packaging, identification marking, and delivery to Owner's storage space. Dispose of other Samples in manner specified for disposal of surplus and waste materials.

2.5 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

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

END OF SECTION 01 78 39

SECTION 01 79 00 - MINIMUM OWNER TRAINING REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. This section is intended to clearly define the requirements for Owner Training. If other sections within the contract documents contain owner training requirements, the most stringent requirements shall supersede.
- B. The term "Owner Training" shall encompass both "demonstration" and "training" as outlined in this specification section and throughout the project.
- C. The Commissioning Agent will be responsible for reviewing and approving all Owner Training for commissioned systems. Non-commissioned systems will be reviewed and approved by the Architect/Engineer.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.3 GENERAL

- A. The c shall coordinate the Owner Training. Owner Training shall be completed according the requirements outlined within this and other specification sections within the contract documents.

1.4 APPLICABLE EQUIPMENT AND SYSTEMS

- A. At a minimum, Contractor shall provide training on all systems including, but not limited to, the following (as applicable to the Project):
 - 1. Architectural Finishes
 - 2. Heating, Ventilating and Air Conditioning equipment; including VRF and DOAS equipment.
 - 3. Building Automation System
 - 4. Electrical System; including Normal and Emergency Power service and distribution equipment as well as interior and exterior lighting and associated controls
 - 5. Plumbing System; including, Water Heaters, Water Treatment, Natural Gas, etc.
 - 6. Life Safety Systems; including Fire Alarm, Voice Annunciation, Fire Suppression, Smoke Control/Evacuation, Controls Systems, etc.
 - 7. Low Voltage Systems; including Wired and Wireless Networks, Public Address, Audio and Visual Equipment, etc.
 - 8. Security Systems; including access control, video monitoring, etc.

1.5 SUBMITTALS

- A. Training Plan: At least 30 days prior to the start of Owner Training, the GC/CM shall provide the training plan to the Architect, Owner and Commissioning Agent for review and approval. The GC/CM shall revise and resubmit until acceptable. The Training Plan shall include the following at a minimum:
1. Overall schedule showing all Owner Training sessions.
 2. Include at least the following for each training session:
 - a. Identification, date, time, and duration.
 - b. Description of products and/or systems to be covered.
 - c. List of all subjects to be covered. See training session requirements located in section 3.2.
 - d. Name of firm and person conducting training; include qualifications.
 - e. Intended audience, such as job description.
 - f. Objectives of training and suggested methods of ensuring adequate training.
 - g. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
 - h. Media to be used, such as slides, hand-outs, etc.
 - i. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.
 - j. Sample attendance record.
 - k. Sample Owner Training Evaluation Forms. Custom forms shall be created for each equipment system to ensure key learning objectives have been achieved.
- B. Training Manuals: The GC/CM shall provide a training manual for each attendee; allow for minimum of two (2) attendees per training session.
1. Include applicable portion of O&M manuals.
 2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
 3. Provide one (1) extra copy of each training manual to be included with operation and maintenance data.
- C. Scheduling – The GC/CM shall coordinate with the Architect, Owner and Commissioning Agent on the date(s) of Owner Training and shall provide at least 14 days' notice prior to training.
- D. Training Reports:
1. Identification of each training session, date, time, and duration.
 2. Sign-in sheet showing names and job titles of attendees.

3. List of attendee questions and written answers given, including copies of and references to supporting documentation required for clarification; include answers to questions that could not be answered in original training session.
 4. Completed Owner Training Evaluation Forms.
- E. Video Recordings: Submit digital video recording of all Owner Training for Owner's subsequent use.
1. Format: DVD Disc and Electronic Format.
 2. Label each disc and container with session identification and date.
 3. Training video shall be broken up, edited, and labeled for each piece of equipment and/or training session.
 4. Electronic Copies shall be included in the Close-Out documentation.

1.6 QUALITY ASSURANCE

- A. Instructor Qualifications: Factory authorized and trained individual who is familiar with the 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

3.1 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 and Commissioning Agent and satisfy all other requirements of this specification.
- B. Demonstrations conducted during Functional Performance Testing need not be repeated unless Owner personnel require additional information.
- C. Demonstration may be combined with training sessions if applicable.
- D. Dynamic 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 (2) weeks prior to Substantial Completion.
 2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six (6) months.
- E. Static Equipment or Systems: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.

1. Perform demonstrations not less than two (2) weeks prior to Substantial Completion.

3.2 TRAINING - GENERAL

- A. GC/CM will prepare the Training Plan based on draft plans submitted.
- B. Conduct Owner Training on-site unless otherwise indicated.
- C. Owner will provide classroom and seating at no cost to Contractor.
- D. Where applicable, do not start Owner Training until Functional Performance Testing is complete, unless otherwise specified or approved by the Commissioning Authority.
- E. Each training session shall cover the following topics at a minimum:
 1. Basis of Design and Operational Requirements including but not limited to:
 - a. General systems and equipment description and function
 - b. Performance and design criteria
 - c. Operational parameters including setpoints, schedules, etc.
 - d. Limiting conditions including safeties, interlocks, alarms, etc.
 - e. Location of all control devices including sensors, actuators, controllers, etc.
 2. Review of project documents including but not limited to:
 - a. Location of turnover documents within the facility
 - b. Location of equipment and systems within facility
 - c. As-Built project record drawings
 - d. O&M Manuals
 - e. Recommended maintenance forms and checklists
 - f. Troubleshooting guides and decision trees
 - g. Warranty information and maintenance agreements
 3. Normal Operation
 - a. Startup process and procedures
 - b. Normal shutdown process and procedures
 - c. Normal operating instructions
 - d. As-built control sequences for all modes of operation
 - e. As-built setpoints and schedules
 - f. Safety procedures
 - g. Seasonal, weekend and holiday operating instructions

4. Emergency Operation
 - a. Explanation of warnings, alarms, trouble indicators and error messages
 - b. Emergency shutdown process and procedures
 - c. Non-normal operation instructions for operating outside normal limits, including failure of components, sensors or subsystems
 - d. Safety procedures
5. Maintenance and Adjustments
 - a. Alignments and adjustments
 - b. Noise and vibration
 - c. Routine cleaning and inspections, including frequency, materials and tools required
 - d. Preventative maintenance activities and frequency, including checklists, materials and tools required
6. Troubleshooting and Repairs
 - a. Identification and diagnostic instructions
 - b. Test and inspection procedures
 - c. Disassembly instructions, including removal and replacement
 - d. Repair instructions
 - e. Identification of parts and components
 - f. Review of attic stock and recommended spare parts

3.3 MINIMUM TRAINING HOURS

- A. The total minimum owner training hours required for each system/equipment are identified below. If the contractor believes hours are insufficient, additional time shall be included in the project to ensure sufficient understanding of all operation and maintenance requirements of equipment and systems.

EQUIPMENT/SYSTEM TYPE	SPECIFICATION SECTION	MINIMUM TRAINING HOURS
ARCHITECTURAL SYSTEMS		
Architectural finishes/systems		
Architectural finishes/systems		
Architectural finishes/systems		
HVAC SYSTEMS		
Building Automation System	230902	8
Dedicated Outdoor Air Unit	237433	4
Variable Refrigerant Flow System Equipment	230903	4
Variable Refrigerant Flow System Controls	230903	2
Power Ventilators	233423	2
Split Systems	238127	2
PLUMBING SYSTEMS		
Domestic Water Heater	223400	2
Thermostatic Mixing Valves	221100	2
Circulation Pump	221123	2
Plumbing Fixture Controls	224000	2
Water Flow Meter	220519	2
ELECTRICAL SYSTEMS		
Switchgear	262726	2
Switchboards and Panelboards	262416	2
Transformers		2
Disconnects	262416	2
Emergency Generator	263213	6
Automatic Transfer Switch	263213	2
Interior Lighting Controls Devices	260923	2
Exterior Lighting Controls Devices	260923	2
Power Meters	262416	2
LIFE SAFETY SYSTEMS		
Fire Pump		2
Fire Alarm System	283111	8
Voice Evacuation System	283111	4
Emergency Responder Radio Coverage System		4
SECURITY SYSTEMS		
Access Control System		4
Closed Circuit TV System		8
LOW VOLTAGE SYSTEMS		
Wired IT Network		6
Wireless IT Network		4
Public Address System		6
Audio System		8

3.4 SCHEDULING

- A. 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.
- B. No single training session may last more than 90 minutes without a minimum of a 15-minute break between sessions.
- C. No more than seven (7) hours of training may be completed in a single day.
- D. Total training hours identified above are intended to be utilized throughout the one-year warranty period as outlined below. Contractor shall plan training time according to enable onsite support at a minimum of each point:
 - 1. Initial owner training at turnover.
 - 2. Three to six (3-6) months after turnover or at first major preventative maintenance cycle to answer questions and re-train on specific items as necessary.
 - 3. Participate at the 10-month warranty review or prior to completion of the 1-year warranty to answer any remaining questions and ensure sufficient knowledge on operation of equipment.

3.5 VIDEO RECORDING

- A. Video recording of all Owner Training shall comply with the following requirements:
 - 1. Video recording shall be done on a device specifically intended for this purpose. Tripods or other stabilizing devices shall be used to ensure a stable, high quality video.
 - 2. Remote microphones shall be utilized to ensure high quality audio and understanding of trainer.
 - 3. Ensure sufficient lighting is provided to observe instructor and all components being trained on.
- B. Any of the following will result in rejection of the training video and require re-training at no additional cost to the owner or count against the minimum hours listed above:
 - 1. Use of cellular phones or tablets for recording device.
 - 2. Use of video cameras without tripods or other stabilizing devices.
 - 3. Poor audio quality due to not using remote microphones or excessive ambient noise.
 - 4. Poor lighting resulting in inability to clearly see equipment or components.

3.6 TRAINING ACCEPTANCE

- A. The Commissioning Agent and/or Architect will review all Owner Training with the Owner's operating personnel and determine if training provided was satisfactory. If training is determined to be insufficient to ensure proper operation and maintenance, additional training will be provided by the contractor at no cost to the owner.
- B. Training will not be deemed acceptable until the following have been completed:
 - 1. Training plan has been approved.
 - 2. All required turnover documents have been received (O&M Manuals, As-Builts, etc.)

3. Training manuals have been approved.
4. Training reports have been approved.
5. Video Recordings have been approved.
6. Owner competence has been confirmed.

END OF SECTION 01 79 00

SECTION 01 91 13: GENERAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. The work under this Section is subject to requirements of the Contract Documents including the Owner's General Conditions and articles of the Construction Manager's General Conditions.
- B. General Commissioning of the project will be executed outside of the general contract by an independent consultant to the owner. Systems Commissioning of the project will be executed outside the general contract by an independent consultant to the Architect. This document states the requirements of the Construction Manager/General contractor to assist the Commissioning Agent in the execution of his work.
- C. Commissioning shall be performed in accordance with the requirements of the Commissioning Standard under which the Commissioning Firm's qualifications are approved or identified within this specification. All quality assurance provisions of the Commissioning Standard such as performance guarantees shall be part of this contract. Commissioning procedures shall be developed by the Commissioning Agent and be in accordance with Commissioning Scope of Work. Where new procedures, requirements, etc. applicable to the Contract requirements have been published or adopted by the body responsible for the Commissioning Standard used (ACG, NEBB, or TABB), the requirements and recommendations in these procedures and requirements shall be considered mandatory.
- D. The commissioning process does not reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product in accordance with the Contract Documents.
- E. This section shall in no way diminish the responsibility of the Division 07, 22, 23, and 26 Contractors, Subs 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 07, 22, 23, and 26 Specifications.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- B. The requirements in this section are in addition to those specifically outlined in:
 - 1. Section 01 79 00 – Minimum Owner Training Requirements
 - 2. Section 01 81 19 – Indoor Air Quality Testing
 - 3. Section 07 08 00 – Commissioning of Building Envelope
 - 4. Section 22 08 00 – Commissioning of Plumbing Systems
 - 5. Section 23 08 00 – Commissioning of HVAC Systems
 - 6. Section 26 08 00 – Commissioning of Electrical Systems

1.3 EQUIPMENT AND SYSTEMS TO BE COMMISSIONED

- A. Commissioning will be performed for the following systems and equipment:

1. Building Envelope; including thermal, air and vapor barriers
2. HVAC Systems and controls; including air and water side equipment
3. Plumbing Systems; including domestic hot water and plumbing fixture controls
4. Electrical Systems; including normal power distribution (through first 480v distribution board), emergency power equipment and distribution (through emergency switchgear and ATS's), exterior lighting controls and interior lighting controls

1.4 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designations only.
1. ASHRAE Guideline 1.1 – HVAC&R Technical Process for the Commissioning Process (2007)
 2. ASHRAE Guideline 0 – The Commissioning Process (2005)
 3. ACG Commissioning Guideline – ACG Commissioning Guideline (2005)
 4. NEBB Commissioning Standard – Whole Building Technical Commissioning of New Construction (2019)
 5. SMACNA 1429 – HVAC Systems Commissioning Manual, 1st Edition (1994)
 6. ANSI/NETA – Standard For Electrical Commissioning of Electrical Power Equipment and Systems (2015)
 7. NIBS Guideline 3 – Building Enclosure Commissioning (2012)
 8. USGBC – LEED v4 Reference Manual

1.5 DEFINITIONS & ABBREVIATIONS

- A. A/E: Architect/Engineer
- B. Acceptance Phase: Phase of construction after startup and initial checkout when Functional Performance Testing, O&M documentation review and training occurs.
- C. Air Barrier Accessory: Products designated to maintain air tightness between air barrier materials, air barrier assemblies and air barrier components, to fasten them to the structure of the building, or both (e.g., sealants, tapes, backer rods, transition membranes, fasteners, strapping, primers).
- D. Air Barrier Assembly: The combination of air barrier materials and air barrier accessories that are designated and designed within the environmental separator to act as a continuous barrier to the movement of air through the environmental separator.
- E. Air Barrier Component: Pre-manufactured elements such as windows, doors, dampers, and service elements that are installed in the environmental separator.
- F. Air Barrier Envelope: The combination of air barrier assemblies and air barrier components, connected by air barrier accessories that are designed to provide a continuous barrier to the movement of air through an environmental separator. There may be more than one air barrier envelope in a single building. Also known as Air Barrier System.

- G. **Air Barrier Material:** A building material that is designed and constructed to provide the primary resistance to airflow through an air barrier assembly.
- H. **BAS:** Building Automation System
- I. **Basis of Design (BOD):** The Engineer's Basis of Design is comprised of two components: The Design Criteria and Design Narrative. These documents record the concepts, calculations, decisions, and product selections used to meet the Owner's Project Requirements and to satisfy applicable regulatory requirements, standards, and guidelines.
- J. **CC:** Controls Contractor
- K. **Certificate of Readiness (COR):** The COR is a document produced by the GC/CM and submitted to the CxA that states specifically indicated systems or equipment are complete installed, started-up, have undergone all testing and checkout and are ready to schedule FPTs.
- L. **Commissioning Agent (CxA):** An independent party, not otherwise associated with the A/E team members or the GC/CM oversees, though he/she may be hired as a subcontractor to them. The CxA directs the day-to-day commissioning activities.
- M. **Commissioning Issue (Cx Issue):** Any component or system condition (static or dynamic) that is in non-conformance with the contract documents, commissioning documents, performance requirements and/or industry standards and adversely affects the commissionability, operability, maintainability, or functionality of a system equipment or components.
- N. **Commissioning Issues log:** A formal and ongoing record of Commissioning Issues or concerns and their resolution that have been raised by members of the Commissioning Team during the commissioning process. Also known as the Corrective Action Log (CAL).
- O. **Commissioning Plan (Cx Plan):** An overall document that provides the structure, schedule and coordination planning for the commissioning process. The Cx Plan identifies the project's commissioning goals, commissioning team members and their roles; establishes the scope of commissioning in terms of systems and equipment; and outlines the major commissioning steps during design, construction, acceptance and occupancy phases. The Cx Plan outlines the expectation of the Contractor's organization, scheduling, allocation of resources, documentation, etc., pertaining to the overall commissioning process.
- P. **Commissioning Final Report:** The final document which presents the commissioning process results for the project. Commissioning reports include an executive summary, issues log, deferred our seasonal testing, and recommendation to accept the project.
- Q. **Commissioning Record:** A compilation of all commissioning related documents produced as part of the project. This record includes but is not limited to final Cx documents, meeting minutes, start-up documents and more. The Cx Record can be combined with the Cx Final Report or be provided as a stand-alone document.
- R. **Commissioning Team (CT):** The qualified group that will plan and carry out the overall commissioning process. The team is composed of the CxA, OR, A/E Team, GC/CM, Subs, equipment manufacturers and other parties identified by the CxA. The individual participants on the team may change as the design and construction process proceeds. Participation by the OR is not mandatory, but the value of this services to the customer is directly proportional to their participation.
- S. **Construction Phase:** Phase of construction that begins once construction commences and continues until TAB and Functional Performance Testing. This phase includes the commissioning submittal review, development and execution of Pre-Functional Checklists, site observations and equipment startup.

- T. Current Facility Requirements (CFR): Similar to the OPR, this document is created during the Acceptance Phase of the project to detail how the completed building is to be operated. The CFR includes modifications in the building's construction, operation or intended use that arose during construction and must be documented for future reference.
- U. Datalogging: Monitoring flows, currents, status, pressures, etc. of equipment using stand-alone data loggers separate from the control system.
- V. Deferred Testing: FPT's that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions that prevent the test from being executed during the Acceptance Phase of the project.
- W. EC: Electrical Contractor
- X. Environmental Separator: The parts of a building that separate the controlled interior environment from the uncontrolled exterior environment, or that separate spaces within a building that have dissimilar environments. Also known as the Control Layer.
- Y. Functional Performance Test (FPT): Testing and documenting of the dynamic function and operation of equipment and systems to verify and demonstration operation in accordance with the OPR, BOD and contract documents. Using manual (direct observation) and/or monitoring methods, systems and equipment are tested under various conditions, such as low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's Sequences of Operation and components are verified to be responding as the sequences state. The CxA develops the FPT procedures in a sequential written form, coordinates, oversees, and documents the actual testing, which is usually performed by the installing contractor or vendor. FPT's are performed after Pre-Functional Checklists, startup, TAB and controls checkout are complete and the COR is received. The Subs are responsible for reviewing, understanding, and performing the FPT's.
- Z. GC/CM: General Contractor / Construction Manager
- AA. HVAC: Heating, Ventilating and Air Conditioning
- BB. Indirect Indicators: Indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100% closed.
- CC. Manual Test: Using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").
- DD. MC: Mechanical Contractor
- EE. Monitoring: The recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or the trending capabilities of control systems.
- FF. Monitoring Based Commissioning Plan: A detailed plan on how the Monitor Based Commissioning process should be executed. This document outlines all of the tasks and their frequency, identifies each party and their roles and responsibilities and establishes guidelines and sample documents for use during the Monitor Based Commissioning process.
- GG. O&M: Operation and Maintenance
- HH. O&M Maintenance Plan: A document produced by the CxA designed to aid the Owner's O&M staff in properly maintaining the building systems.

- II. Occupancy Phase: Phase of the project after the Acceptance Phase. During this phase, commissioning requirements are to correct any remaining Commissioning Issues, carry out any required re-testing, deferred or seasonal testing, close-out documentation review and warranty review.
- JJ. Ongoing Commissioning Plan: A detailed plan on how to execute Ongoing Commissioning. This plan should provide the Owner's O&M staff with procedures, a schedule for implementation and blank testing documents.
- KK. Owner's Project Requirements (OPR): A written document that details the project requirements and the expectations of the Owner for how the building and its systems must be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.
- LL. OR: Owner's Representative
- MM. Over-written Value: Writing over a sensor value in the control system to see the response of a system (e.g., changing the outside air temperature value from 50°F to 75°F to verify economizer operation). See also "Simulated Signal".
- NN. PC: Plumbing Contractor
- OO. Pre-Functional Checklist (PFC): A list of items to inspect to verify proper installation of equipment and systems. PFCs are developed and provided by the CxA with execution being completed by the Subs, CxA or a combination thereof depending on the scope of services. PFCs are primarily static inspections and procedures to prepare the equipment or system for initial operations (e.g., belt tension, oil levels OK, labels affixed, gages in place, etc.).
- PP. Request for Information (RFI): An official document submitted to the A/E to provide clarity or direction on a specific question or issue that has arisen.
- QQ. Sampling: Performing observation, review, testing or other verification on only a fraction of the total number of identical or near identical pieces of equipment, drawings, events, etc. Sampling techniques include random statistical sampling and less form professional judgment methods.
- RR. Seasonal Testing: FPTs that are deferred until the system(s) will experience conditions closer to their design conditions.
- SS. Sequence of Operations (SOO): A written description of how equipment and systems are intended to operate. SOOs include control logic, setpoints, alarm requirements, trend requirements and other information necessary to properly program and commission the system. SOOs are developed by the EOR, and final versions are provided by the CC on the approved controls submittal.
- TT. Simulated Condition: Condition that is created for the purpose of testing the response of a system.
- UU. Simulated Signal: Disconnecting a sensor and using a signal generator to send an amperage, resistance or pressure to the transducer and DDC system to simulate a sensor value.
- VV. Start-up: The initial starting or activating of dynamic equipment, including executing Pre-Functional checklists.
- WW. Subs: Subcontractors
- XX. Systems Manual: A system-focused composite manual organized by system which contains the information needed to optimally operate the building equipment and systems. The manual consists of troubleshooting information and final Sequences of Operations, setpoints and controls diagrams. The Systems Manual is not a replacement for the O&M manuals provided by the GC/CM.

YY. TAB: Testing, Adjusting and Balancing

ZZ. TABC: Testing, Adjusting and Balancing Contractor

AAA. Test Procedures: The step-by-step process which must be executed to fulfill the test requirements. The test procedures are developed by the CxA with assistance and coordination from GC/CM and Subs.

BBB. Test Requirements: Requirements specifying what modes and functions, etc. shall be tested. The test procedures are not the detailed test procedures. The test requirements are specified in the Contract Documents.

CCC. Trending: Monitoring of BAS information by logging data at set intervals or when there is a change of value.

1.6 COMMISSIONING TEAM

A. Commissioning requires the participation of all project team members to be an effective and efficient process. This team is made of individuals from the Owner, Design and Construction teams as identified in this section. The commissioning team is fluid, and additional project team members may be added as needed throughout the project.

B. Commissioning Team members appointed by Owner:

1. CxA – Commissioning Agent
2. OR – Owner's Representative, ideally member(s) of the O&M staff
3. A/E – Architect and Engineering design professionals

C. Commissioning Team members appointed by the Contractor(s):

1. GC/CM – General Contractor/Construction Manager
2. MC – Mechanical Contractor
3. EC – Electrical Contractor
4. PC – Plumbing Contractor
5. CC – Controls Contractor
6. TABC – TAB Contractor
7. Equipment Suppliers and Vendors
8. Envelope Contractor(s)

1.7 COMMISSIONING SUBMITTALS

A. This section identifies the commissioning submittals that the GC/CM and A/E are responsible for providing to the CxA for completion of commissioning related tasks.

B. Construction Documents, RFIs, Sketches and other design documents:

1. The A/E shall provide the CxA all current design documents. When contract document updates are issued, the CxA shall be included on the distribution of those documents.

2. The CxA shall receive copies of all drawing updates that are not provided as part of official document updates, such as sketches.
 3. The GC/CM and A/E shall ensure the CxA receives copies of all RFIs related to commissioned systems. This includes both the original RFI submitted to the A/E as well as any response provided. The CxA may provide input on RFIs to the A/E.
- C. Construction Submittals:
1. The CxA will identify submittals to the GC/CM that are required concurrent with the submission to the A/E. The CxA's review shall be limited to the equipment being commissioned with the commissioning review focused on confirming compliance with the contract documents. The CxA will provide commissioning review comments to the A/E.
 - a. The CxA will only review the initial submittal for equipment being commissioned. All re-submittals shall be provided to the CxA, it shall be at the CxA's discretion to review any additional re-submittals.
 2. The GC/CM shall provide final approved copies of the submittals to the CxA for development of project specific commissioning documentation.
- D. Start-Up Plan:
1. The GC/CM, with assistance from the Subs and equipment vendors responsible for purchase, installation and start-up of equipment, shall develop a Start-Up Plan and executes equipment start-up utilizing the following procedure.
 - a. Compile detailed start-up and checkout procedures from equipment manufacturers and industry standard field checkout sheets. Start-up documentation shall include checklists and procedures with specific boxes or lines for recording and documenting inspections of each piece of equipment.
 - b. Submit the Start-Up Plan to the CxA for review in discipline specific books/sections which shall include the following at a minimum:
 - i. Cover sheet for each Start-Up Plan book/section. Each Start-Up Plan shall have an individual, discipline specific tag (e.g. Mechanical Start-Up Plan (Volume 1, 2, 3, etc.), Electrical Start-Up Plan, Plumbing Start-Up Plan, etc.).
 - ii. Table of Contents for each book/section.
 - iii. Schedule of start-up activities by equipment (initial Start-Up Plan submittal schedule shall be tentative; start-up schedule shall be updated as construction proceeds and forwarded to CxA so that CxA can witness start-up activities as required).
 - iv. Separate tagged divider by specification section with all related systems testing documentation (duct pressure testing, duct cleaning, piping flushing and pressure testing, electrical acceptance testing, etc.).
 - v. Separate tagged divider by specification section with start-up checklists and documentation for each item of equipment.
 2. The CxA, A/E and OR reviews the Start-Up Plan for content and format. The CxA shall return the Start-Up Plan with comments to GC/CM and the GC/CM shall revise the Start-Up Plan based on CxA comments.

3. The GC/CM shall forward copies of completed Start-Up Plan sections as the work is completed, including all executed start-up checklists, to CxA for review to verify completion of start-up activities. An executed Start-Up Plan must be submitted to CxA prior to scheduling of FPTs.
4. Once all start-up activities are complete, the GC/CM shall submit a complete, compiled Start-Up plan for documentation. Any comments made by the CxA on individual section submissions shall be incorporated.

E. CORs:

1. The GC/CM shall submit completed CORs to the CxA for each piece of equipment or system prior to scheduling and execution of FPTs.
2. At a minimum, COR must confirm and certify that the following:
 - a. PFCs are complete and submitted to the CxA.
 - b. All previously identified Cx Issues for the related equipment/system have been resolved and verified.
 - c. Start-up and checkout activities have been completed successfully and all documents have been submitted to the CxA.
 - d. TAB is complete and all documentation has been submitted to the CxA.
 - e. Controls programming is complete and operational, including graphical user interface, trending, alarming, scheduling and other systems necessary for a complete BAS.
 - f. Subs and/or manufacturers' representatives will be made available as necessary for the execution of FPTs.
3. Each COR shall include the following for both the GC and associated Subs:
 - a. Printed Name
 - b. Title
 - c. Company
 - d. Signature
 - e. Date
4. Sample COR templates can be provided by the CxA.

F. Training Plan:

1. The GC/CM shall develop and complete the Training Plan as outlined in section 01 79 00.

G. Turnover Documents:

1. The GC/CM shall provide the following turnover documents to the CxA for review:
 - a. As-Built Drawings, including final controls SOOs and Setpoints.
 - b. O&M Manuals

- c. Systems Manual
- d. Owner Training Documents

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

- A. All testing equipment required to perform startup and initial checkout and required FPTs shall be provided by the GC/CM, Subs or equipment vendors for the equipment being tested.
- B. Special equipment, tools, and instruments (only available from vendor, specific to a piece of equipment) required for testing or maintaining equipment shall be included in the base bid price to the GC/CM and shall be left on site for use by the Owner's O&M staff.
- C. 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.
- D. Reference discipline specific specification sections for additional test equipment requirements.

PART 3 EXECUTION

3.1 COMMISSIONING PROCESS OVERVIEW

- A. The following provides a brief overview of the commissioning tasks during the construction, acceptance, and occupancy phases and are listed in the approximate order in which they occur:
 - 1. Submittals for commissioned systems and equipment are provided to the CxA by the GC/CM concurrent to the A/E as part of the normal submittal process.
 - 2. Final approved submittals are forwarded to the CxA by the GC/CM or Subs for use by the CxA during the commissioning process.
 - 3. The CxA develops equipment specific PFCs.
 - 4. Prior to executing onsite work, the CxA will organize and lead a Commissioning Kick-Off meeting. This meeting involves the entire CT and provides a thorough review of the upcoming commissioning tasks, discusses roles and responsibilities and answers any commissioning related questions.
 - 5. The CxA ensures all PFCs are completed prior to equipment start-up and execution of FPTs.
 - 6. The CxA develops project specific FPT plans. These plans are created by using both the contract documents and approved submittals. FPT plans are provided to the GC/CM, Subs, A/E and OR for review and comment.
 - 7. The GC/CM coordinates and executes equipment startup and checkout activities.
 - 8. TAB is executed and documentation is submitted according to the contract documents.
 - 9. The GC/CM submits CORs to the CxA to indicate systems and equipment are ready to begin executing FPTs.
 - 10. The CxA coordinates the execution of the FPTs with the assistance of the Subs.
 - 11. Owner Training is completed by the GC/CM in accordance with the contract documents.

12. The CxA issues the Cx Final Report and Cx Record. These documents may be a single file.
13. The Cx participates in the 10-Month Warranty review and issues a report.

3.2 ROLES AND RESPONSIBILITIES

- A. The general responsibilities of various commissioning team members are provided in this subsection. Specific responsibilities will be provided in the Cx Plan.
- B. OR's Responsibilities:
 1. Develop and provide the approved OPR to the CxA, A/E and GC/CM for information and use.
 2. Update the OPR as necessary throughout the project.
 3. Facilitate, support and participate in the commissioning process.
 4. Provide final approval of the commissioning work.
- C. Architect/Engineer Responsibilities:
 1. Develop and provide the OR Approved BOD document to the CxA.
 2. Attend selected commissioning meetings as needed or requested by the CxA.
 3. Provide copies of all design documents including all drawings, specifications and revisions to those documents, sketches, RFIs or other documents that modify the project design.
 4. Review and respond to any Design Review Comments. Incorporate any necessary changes in future drawing releases.
 5. Review CxA Submittal Review comments. Any comments deemed valuable shall be incorporated into official submittal responses by the A/E. Any comments that are not included shall be provided written responses from the A/E detailing why for record purposes.
 6. Participate in the resolution of Commissioning Issues identified during the project as needed or requested by the CxA.
 7. Review and comment on FPT plans developed by the CxA to ensure compliance with the design intent of the system and equipment.
 8. Review and approval all final Cx Documents produced the CT members.
- D. General Contractor/Construction Manager Responsibilities:
 1. Incorporate commissioning activities and milestones into the overall project schedule. Provide updates as necessary.
 2. Ensure all Subs and equipment vendors fully participate in the commissioning process and execute their responsibilities.
 3. Attend, along with all necessary Subs, commissioning progress and coordination meetings.
 4. Provide the CxA copies of all OAC meeting minutes, RFIs and other construction progress or change related documents.
 5. Notify the CxA when equipment is ready for observation, PFC and FPT completion.
 6. Coordinate with the CxA regarding planning, scheduling and execution of all startup and testing activities. Submit all plans, reports and completed forms to the CxA and A/E for review and approval.
 7. Coordinate with appropriate Subs and vendors to ensure timely resolutions to commissioning

issues.

8. Review and comment on the FPT plans developed by the CxA.
9. Ensure Subs provide technicians, equipment or other tools requested by the CxA in order to complete commissioning activities including but not limited to the execution of FPTs.
10. Submit CORs to the CxA prior to scheduling FPTs.
11. Compile and submit all closeout and turnover documents to the A/E and CxA for review and approval including but not limited to As-Built drawings and O&M Manuals.
12. Coordinate and execute Owner Training in accordance with the contract documents, specifically section 01 79 00 Minimum Owner Training Requirements.
13. Participate in the 10-Month warranty review and ensure resolution of all identified issues prior to the completion of the warranty period.

E. Commissioning Agent's Responsibilities:

1. Organize and lead the Commissioning Team in the execution of all commissioning activities.
2. Develop the Commissioning Plan and Commissioning Specifications that clearly define the commissioning process and team member roles and responsibilities and provide sample documentation.
3. Review the contract documents for constructability, commissionability and maintainability.
4. Review submittal documents for conformance with the contract documents for commissioned systems and equipment.
5. Develop equipment specific Pre-Functional Checklists and project specific Functional Performance Test scripts.
6. Plan and lead commissioning related meetings as necessary to coordinate commissioning tasks and discuss commissioning issues.
7. Conduct periodic site visits to collect commissioning documents and completed a back check of contractor completed PFCs, review progress of installation and document Commissioning Issues.
8. Develop and maintain the Cx Issues Log to track all identified Cx Issues, resolutions and commentary from the GC/CM, Subs, OR and A/E.
9. Provide regular reports on progress of the commissioning activities, including any currently unresolved Commissioning Issues.
10. Participate in the GC/CM's startup process by reviewing startup plans, witnessing selected startup activities and reviewing completed startup documentation.
11. Verify that TAB work is completed properly by reviewing the TAB report and performing limited verification with the assistance of the TABC.
12. Review turnover documents for completeness and accuracy including but not limited to As-Built drawings, O&M Manuals and the Systems Manual.
13. Verify Owner Training has been completed according to the Minimum Owner Training Requirements.
14. Develop the CFR, O&M Plan, and Ongoing Cx Plan for use by the Owner's O&M staff.
15. Develop the Monitor Based Cx Plan.
16. Develop and issue the Cx Final Report. The Cx Record may be included as part of the Cx Final

Report or be issued as a separate document.

17. Recommend acceptance of the commissioned equipment and systems to the OR.
18. Complete any necessary LEED documentation related to the commissioning process.
19. Direct and witness any seasonal or deferred FPTs that could not be completed during the acceptance phase FPT period.
20. Participate in the 10-Month Warranty Review. Issue a report indicating any outstanding items the GC/CM should resolve prior to the completion of the warranty period.
21. Plan and conduct a project close-out and lessons learned meeting with the OR, GC/CM and A/E.

3.3 SCHEDULING AND COORDINATION

- A. Kick-off Meeting: Prior to beginning onsite work the CxA will plan, schedule and conduct a commissioning kick-off meeting. Roles and responsibilities of the Commissioning Team will be clarified at this meeting along with a review of the Cx Plan. The CxA will distribute meeting minutes to all parties.
- B. The CxA will work with GC/CM to established protocols to schedule the commissioning activities. The CxA will review the Construction Schedule and verify that PFCs and FPTs are properly scheduled. The GC/CM will integrate all commissioning activities into the master schedule.
- C. The GC/CM shall notify the CxA of any changes in the construction schedules that will affect commissioning activities. The CxA will work with the GC/CM and Sub(s) to schedule new dates as necessary. The GC/CM shall notify the CxA a minimum of five (5) days in advance of scheduled commissioning visits if re-scheduling is required.
 1. Any time for the CxA to visit the site to execute commissioning tasks on equipment or systems that were identified as being ready by the GC/CM but found to not be will be back charged to the GC/CM at a cost of \$2,500 plus expenses per man-day.
- D. The GC/CM and Sub(s) shall schedule their representatives as required by the CxA to complete all commissioning activities.

3.4 PRE-FUNCTIONAL CHECKLISTS

- A. Objectives and Scope:
 1. The objective of PFCs is to verify and document that the equipment/systems are provided and installed according to the contract documents, manufacturers recommendations and industry standards. Each piece of commissioned equipment shall receive a PFC that must be completed and approved prior to start-up.
- B. Development of Documents:
 1. The CxA is responsible for developing equipment specific PFCs for each piece of commissioned equipment. No equipment shall share completed PFC documents.
 2. Sample PFCs are provided in the Cx Plan and can be obtained from the CxA. The samples are provided to give the Subs a general idea of the content and scope of the PFC process. The sample PFCs are prototypical, and do not reflect specific requirements of this project's plans or specifications.
- C. Execution:
 1. Subs are responsible for executing all PFCs and shall provide the CxA with signed and dated copies of completed PFCs prior to verification by the CxA. Only individuals having direct knowledge that a line item task was actually performed will complete that line item. Subs shall clearly list PFC items not completed successfully. Completed forms documenting any outstanding deficiencies shall be provided to CxA within two (2) working days of completion.

2. The CxA will verify the PFCs completed by the Subs. Verification includes review of completed checklist items and random back-checking of submitted data to confirm accuracy. Any issues identified will be added to the Cx Issues Log and may delay start-up or FPTs.
3. Any PFC item or associated Cx Issue marked as complete which is later found to be incomplete and causes re-verification work by CxA or delays during FPTs will be back- charged to the responsible party.

3.5 START-UP AND INITIAL CHECKOUT

- A. The GC/CM shall develop the Start-Up Plan and submit to the CxA, A/E, and OR for approval a minimum of thirty (30) days prior to the anticipated start of start-up activities.
- B. After receiving approval of the Start-Up Plan, the GC/CM shall organize and lead a Start-Up Coordination Meeting. All CT members shall attend and provide feedback on start-up activities.
- C. Subs and/or equipment vendors shall execute equipment start-up per the Start-Up Plan.
- D. The CxA will witness and document start-up of select equipment.
- E. The GC/CM shall notify the CxA of any changes to the start-up schedules that will affect commissioning activities. The CxA will work with the GC/CM and Sub(s) to schedule new dates as necessary. The GC/CM shall notify the CxA a minimum of five (5) days in advance of scheduled commissioning visits if re-scheduling is required.
 1. Any time for the CxA to visit the site to execute commissioning tasks on equipment or systems that were identified as being ready by the GC/CM but found to not be will be back charged to the GC/CM at a cost of \$2,500 plus expenses per man-day.
- F. The GC/CM shall provide the CxA with signed and dated copy of completed Start-Up Plan documents prior to scheduling of FPTs. Only individuals having direct knowledge that a line item task was actually performed shall complete the documentation.
- G. Subs shall clearly list outstanding items or initial start-up tests that are not completed successfully. Completed forms documenting any outstanding deficiencies shall be provided to CxA within two (2) working days of completion.

3.6 FUNCTIONAL PERFORMANCE TESTS

- A. Objective and Scope:
 1. The purpose of FPTs is to document and verify that all equipment and systems are operating according to the design intent and as defined in the contract documents and approved submittals. The process of FPTs facility bringing a system from a state of substantial completion to fully dynamic operation.
 2. Each component and system are operated through all modes of operation (occupied, unoccupied, etc.) where specific equipment and system responses are required. All control SOOs are tested and verified, including all safeties and alarms.
 3. FPTs are only performed on dynamic pieces of equipment. Static system components (i.e. panelboards, louvers, etc.) do not undergo FPTs.
- B. Development of Documents:
 1. The CxA will develop project specific test procedures and forms to verify and document equipment and system operation. These test procedures are developed from a combination of the contract documents and approved submittals.
 - a. The GC/CM shall provide all documents requested by the CxA for the development of FPT test procedures.
 - b. The GC/CM shall authorize the Subs and equipment vendors to assist the CxA in

development of the test procedures as requested by the CxA.

2. Once developed, the CxA will issue the FPT test procedures to the CT for review and comment. It is imperative that all members thoroughly review these procedures for feasibility, safety, and warranty protection as well as conformance to the design intent. If necessary, the CxA will coordinate a meeting to discuss any concerns. Based on CT feedback, the CxA will make any necessary updates to the FPT test procedures.
 - a. Failure to properly review FPT test procedures and identify any feasibility or other issues by the GC/CM, Subs or equipment vendors during the review period that are identified during test execution will be handled as non-conformance Cx Issues.

C. Execution:

1. Prior to scheduling FPT execution, complete CORs must be received by the CxA and all associated documentation. All start-up, checkout, TAB and other testing must be complete and final prior to FPTs.
2. The GC/CM shall provide the CxA a minimum of fourteen (14) days' notice for when FPTs may begin.
3. The CxA will conduct an FPT coordination meeting with the CT. This meeting will serve to schedule the execution of FPTs, answer any questions and remind each CT member of their roles and responsibilities.
4. The GC/CM shall ensure that the Subs and/or equipment vendors provide trained technicians familiar with the project to assist in the execution of FPTs.
5. The Subs and/or equipment vendor technicians will execute the FPT test procedures. The CxA will direct and document the results of the FPT.
6. FPTs will be completed under design conditions whenever possible. Simulated conditions or signals may be used when not practical under design conditions as the discretion and direction of the CxA. The CxA will determine how to best simulate the conditions needed for the test.
7. If any line of an FPT test procedure is unsuccessful or fails, that line item and/or test section will be deemed to be in non-conformance and identified as a Commissioning Issue.
8. When an FPT is completed and any identified Commissioning Issues are resolved, the CxA, GC/CM, Subs and/or equipment vendor shall sign off that testing is complete and successful, and the equipment is ready to be turned over to the Owner.

D. Deferred Testing:

1. If any FPT cannot be completed due an unforeseen condition outside the control of the GC/CM or CxA, execution shall be deferred based on the recommendation of the CxA and approval of the OR. The affected testing shall be completed as soon as practical.
2. Costs associated with deferred testing are the responsibility of the GC/CM, Subs and equipment vendors. Deferred tests are tests that have not been performed, therefor any costs associated with those tests have not been utilized.

E. Seasonal Testing:

1. Seasonal testing are FPTs that are executed during the opposite season of the initial FPTs. The intent of seasonal testing is to verify equipment operation during both weather extremes.
2. Seasonal testing shall be executed during ASHRAE design condition months. If possible, scheduling should be flexible to coordinate testing on days as close to design condition as possible.
3. The GC/CM shall ensure participation by the Subs and/or equipment vendors. The same technician made available during the initial FPTs shall be made available for seasonal testing.

4. Costs associated with seasonal testing shall be covered by the CxA, Subs and equipment vendors for their respective resources.

3.7 NON-CONFORMANCE AND COMMISSIONING ISSUES

- A. The CxA will document any observations, installation issues or operational non-conformance issues as Commissioning Issues and be tracked in the Commissioning Issues Log.
- B. All Commissioning Issues identified prior to the execution of FPTs must be resolved by the GC/CM and Subs and verified by the CxA prior to scheduling FPTs.
- C. Non-conformance Commissioning Issues identified during the execution of FPTs must be completed prior to release of the GC/CM and Subs retainage.
- D. Commissioning Issues will be handled in the following manner:
 1. When there is no dispute on the Cx Issue and Subs accept responsibility for remedial action:
 - a. The CxA documents the Cx Issue in the Cx Issues Log and distributes to the CT.
 - b. The GC/CM facilitates the resolution of the issue and assigns Cx Issues to the appropriate Subs and equipment vendors.
 - c. Subs and equipment vendors make necessary modifications and submit written response to GC/CM stating necessary changes have been made. GC/CM reviews the work and forwards the response to the CxA if they agree that the Cx Issue is resolved.
 - d. The CxA verifies the resolution is satisfactory and indicates the Cx Issue as corrected.
 2. When there is a dispute about the Cx Issue regarding whether the issue is valid or who is responsible:
 - a. The CxA documents the Cx Issue in the Cx Issues Log and distributes to the CT.
 - b. The GC/CM facilitates the resolution of the issue. If assistance is needed, additional parties may be brought into the discussions, including the CxA. Final interpretive authority is with the A/E. Final acceptance authority is with the OR.
 - c. The CxA documents the final interpretation and resolution process.
 - d. If Subs and equipment vendors are to make necessary modifications and submit written response to GC/CM stating necessary changes have been made. GC/CM reviews the work and forwards the response to the CxA if they agree that the Cx Issue is resolved.
 - e. The CxA verifies the resolution is satisfactory and indicates the Cx Issue as Corrected.
 - f. If the A/E or OR are going to accept the Cx Issue as is, the Cx Issues Log shall be updated to indicate the issue as Accepted.
- E. Costs associated with verification or re-testing of Cx Issues:
 1. Costs Subs or equipment vendors to re-verify Cx Issues identified during the project, if they are responsible for the issue, will be theirs.
 2. If Subs are not responsible for a Cx Issue but are required for verification or re-testing, cost recovery may be negotiated with the GC/CM.
 3. Time for the CxA to conduct verification of Cx Issue resolutions or re-testing due to Cx Issues being reported as resolved but found to not be will be back charged to the responsible Subs at a cost of \$2,500 plus expenses per man-day.

3.8 OWNER TRAINING

- A. The GC/CM is responsible for execution of Owner Training as outlined in section 01 79 00.

3.9 10-MONTH WARRANTY

- A. Approximately ten (10) months into the one-year warranty period the CT will participate in a warranty period review meeting with the OR and O&M staff to review the facility and its performance.
- B. This Warranty Review meeting shall address:
1. Any outstanding construction deficiencies, including A/E punch list items and Cx Issues Log issues.
 2. Any additional deficiencies identified by the operations staff since the start of the occupancy phase.
 3. Any issues noted by the O&M staff relating to the operation of the facility efficiently and as intended.
 4. Any re-training requested by the O&M staff.
- C. The CxA will provide a 10-Month Warranty Review Report. This report shall indicate all work required of the GC/CM prior the expiration of the one-year warranty.
- D. The GC/CM will ensure any identified issues are resolved prior to the expiration of the warranty period to the satisfaction of the OR and O&M Staff. If sufficient time to remedy the issue does not exist, the warranty period shall be extended for the equipment/systems/components in question.

END OF SECTION 01 91 13

SECTION 02 41 19 DEMOLITION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Building demolition excluding removal of hazardous materials and toxic substances.
- B. Selective demolition and removal of built site elements.
- C. Selective demolition and removal of building elements or structure for alteration purposes.
- D. Removal of existing items to be salvaged or reinstalled.

1.2 RELATED REQUIREMENTS

- A. Section 01 10 00 - Summary: Limitations on Contractor's use of site and premises.
- B. Section 01 10 00 - Summary: Sequencing and staging requirements.
- C. Section 01 10 00 - Summary: Description of items to be salvaged or removed for re-use by Contractor.
- D. Section 01 50 00 - Temporary Facilities and Controls: Site fences, security, protective barriers, waste removal, dust control, and heating or cooling.
- E. Section 01 60 00 - Product Requirements: Handling and storage of items removed for salvage and relocation.
- F. Section 01 70 00 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.
- G. Section 02 65 00 - Underground Storage Tank Removal.
- H. Section 31 22 00 - Grading: Rough and fine grading.
- I. Section 31 23 23 - Fill: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

1.3 DEFINITIONS

- A. Demolition: Dismantle, raze, destroy or wreck any building or structure or any part thereof.
- B. Remove: Detach or dismantle items from existing construction and dispose of them off site, unless items are indicated to be salvaged or reinstalled.
- C. Remove and Salvage: Detach or dismantle items from existing construction in a manner to prevent damage. Clean, package, label and **deliver salvaged items** to Owner in ready-for-reuse condition.
- D. Remove and Reinstall: Detach or dismantle items from existing construction in a manner to prevent damage. Clean and prepare for reuse and reinstall where indicated.
- E. Existing to Remain: Designation for existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- F. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIAL OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Storage or sale of removed items or materials on-site is not permitted.

1.5 PERFORMANCE REQUIREMENTS

- A. Regulator Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.6 REFERENCE STANDARDS

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

1.7 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protections, for dust control, and for noise control. Indicate proposed locations and construction of barriers.
- C. 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.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
- D. Demolition Plan: Submit demolition plan as required by OSHA and local AHJs.
 - 1. Indicate extent of demolition, removal sequencing, bracing and shoring, and location and construction of barricades and fences.
 - 2. Demolition firm qualifications.
- E. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.8 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Company specializing in the type of work required.
 - 1. Minimum of Two (2) years of documented experience.

1.9 PREINSTALLATION MEETINGS

- 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.

1.10 FIELD CONDITIONS

- A. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

1.11 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.

- B. Notify warrantor upon 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

3.1 DEMOLITION

- A. Remove the entire building designated ____.
- B. Remove portions of existing buildings in the following sequence:
- C. Remove paving and curbs required to accomplish new work.
- D. Remove all other paving and curbs within site boundaries.
- E. Within area of new construction, remove foundation walls and footings.
- F. Remove concrete slabs on grade as indicated on drawings.
- G. Remove manholes and manhole covers, curb inlets and catch basins.
- H. Remove fences and gates.
- I. Remove creosote-treated wood utility poles.
- J. Remove other items indicated, for salvage, relocation, recycling, and ____.
- K. Fill excavations, open pits, and holes in ground areas generated as result of removals, using specified fill; compact fill as specified in Section 31 22 00.

3.2 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Comply with applicable requirements of NFPA 241.
 - 3. Use of explosives is not permitted.
 - 4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 5. Provide, erect, and maintain temporary barriers and security devices.
 - 6. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
 - 7. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 8. Do not close or obstruct roadways or sidewalks without permits from authority having jurisdiction.
 - 9. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from removal operations.
 - 10. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon, or limit access to their property.
- B. Do not begin removal until receipt of notification to proceed from Owner.
- C. Do not begin removal until built elements to be salvaged or relocated have been removed.
- D. Do not begin removal until vegetation to be relocated has been removed and vegetation to remain has been protected from damage.
- E. Protect existing structures and other elements to remain in place and not removed.

1. Provide bracing and shoring.
2. Prevent movement or settlement of adjacent structures.
3. Stop work immediately if adjacent structures appear to be in danger.
- F. Minimize production of dust due to demolition operations. Do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- G. Hazardous Materials:
 1. It is not expected that hazardous material will be encountered in the Work.
 2. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCBs, and mercury.
- H. Perform demolition in a manner that maximizes salvage and recycling of materials.
 1. Dismantle existing construction and separate materials.
 2. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.
- I. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.
- J. Underground Storage Tanks: Remove and dispose of as specified in Section 02 65 00.

3.3 EXAMINATION

- A. **Survey existing structures and vegetated areas on-site for the existence of wildlife before proceeding with building and site demolition operations.**
 1. **Wildlife shall be removed by a wildlife removal professional.**
 2. Wildlife shall be moved/relocated in a humane and ethical manner. Termination shall be of last resort and only after review and approval of both Owner and Architect.
- B. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- C. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are the same as those indicated in Project Record Documents.
- D. If required, verify that hazardous materials have been remediated before proceeding with building demolition operations.
- E. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- F. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.

3.4 EXISTING UTILITIES

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

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

3.5 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. 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.
 - 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. 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 portable fire-suppression devices during flame-cutting operations.
 - a. Maintain fire watch during and for at least a half hour after flame-cutting operations.
 - b. Maintain adequate ventilation when using cutting torches.
 - 5. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 - 6. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 - 7. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- B. Remove and Salvage Items:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to Owner's storage area designated by Owner or as indicated on Drawings.
 - 5. Protect items from damage during transport and storage.
- C. Remove and Reinstalled Items:
 - 1. Clean and repair items to functional condition adequate for intended reuse.
 - 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 - 3. Protect items from damage during transport and storage.
 - 4. 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.
- D. Existing construction and utilities indicated on drawings are based on casual field observation and existing record documents only.

1. Verify construction and utility arrangements are as indicated.
2. Report discrepancies to Architect before disturbing existing installation.
3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- E. Maintain weatherproof exterior building enclosure, except for interruptions required for replacement or modifications; prevent water and humidity damage.
- F. Remove existing work as indicated and required to accomplish new work.
 1. Remove items indicated on drawings.
- G. Services including, but not limited to, HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications: Remove existing systems and equipment as indicated.
 1. Maintain existing active systems to remain in operation, and maintain access to equipment and operational components.
 2. 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.
 3. Verify that abandoned services serve only abandoned facilities before removal.
 4. 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.
- H. Protect existing work to remain.
 1. Prevent movement of structure. Provide shoring and bracing as required.
 2. Perform cutting to accomplish removal work neatly and as specified for cutting new work.
 3. Repair adjacent construction and finishes damaged during removal work.
 4. Patch to match new work.

3.6 PROTECTION

- A. Temporary Protection: Provide temporary protection methods 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 areas.
 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.
- B. Temporary Shoring: Design, 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.
- C. Remove temporary barricades and protections where hazards no longer exist.

3.7 DEBRIS AND WASTE REMOVAL

- A. Remove debris, junk, and trash from site.
 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. Do not burn demolished materials.
- B. Remove materials not to be reused on site; comply with requirements of 01 74 19 - Construction Waste Management and Disposal..

3.8 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 02 41 19

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SECTION 02 41 00 – SITE DEMOLITION

PART 1 – GENERAL

1.1 WORK INCLUDES

- A. Demolition of structures, paving, and utilities.
- B. Filling voids created as a result of removals or demolition.

1.2 RELATED WORK

- A. Specified Elsewhere:
 - 1. Section 31 23 16 – Excavation
 - 2. Section 31 23 23 – Fill
 - 3. Section 31 25 00 – Erosion and Sedimentation Control (with SWPPP)

1.3 REGULATORY REQUIREMENTS

- A. Conform to applicable State and local codes for demolition of structures, safety of adjacent structures, dust control, and runoff control.
- B. Obtain required permits and licenses from appropriate authorities. Pay associated fees including disposal charges.
- C. Notify affected utility companies before starting work and comply with their requirements.
- D. Do not close or obstruct public or private roadways, sidewalks, or fire hydrants without appropriate permits or written authorization.
- E. Conform to applicable regulatory procedures when hazardous or contaminated materials are discovered.

1.4 REFERENCES

- A. Conform to the applicable portions of Sections 202 and 203 of the Missouri Department of Transportation (MoDOT): Standard Specifications for Highway Construction, including all Supplemental Specifications and Recurring Special Provisions.

1.5 SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of capped utilities and subsurface obstructions that will remain after demolition. Submit record as part of closeout submittals.

1.6 PROJECT CONDITIONS

- A. Structures to be demolished will be discontinued in use and vacated prior to start of work.
- B. Owner assumes no responsibility for condition of structures to be demolished.
- C. Conditions existing at time of inspection for bidding purposes will be maintained by Owner as reasonably practical. Variations within structures may occur by Owner's removal and salvage operations prior to start of demolition work.
- D. Unless otherwise indicated in Contract Documents or specified by the Owner, items of salvageable value to Contractor shall be removed from site and structures. Storage or sale of removed items on site will not be permitted and shall not interfere with other work specified.
- E. Explosives shall not be brought to site or used without written consent of authorities having jurisdiction. Such written consent will not relieve Contractor of total responsibility for injury to persons or for damage to property due to blasting operations. Performance of required blasting shall comply with governing regulations.

PART 2 – PRODUCTS

2.1 FILL MATERIALS

- A. Fill material shall be as specified in Section 31 23 23.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Provide, erect, and maintain erosion control devices, temporary barriers, and security devices at locations indicated on Construction Drawings.
- B. Protect existing landscaping materials, appurtenances, and structures, which are not to be demolished. Repair damage to existing items to remain caused by demolition operations.
- C. Prevent movement or settlement of adjacent structures. Provide bracing and shoring as necessary.
- D. Mark location of utilities. Protect and maintain in safe and operable condition utilities that are to remain. Prevent interruption of existing utility service to occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities as acceptable to governing authorities and Owner.
- E. Notify adjacent property owners of work that may affect their property, potential noise, utility outages, or other disruptions. Obtain written permission from adjacent property owners when demolition equipment will traverse, infringe upon, or limit access to their property. Coordinate notice with Owner.

3.2 GENERAL DEMOLITION REQUIREMENTS

- A. Conduct demolition to minimize interference with adjacent structures or pavements to remain.
- B. Cease operations immediately if adjacent structures appear to be in danger. Notify authority having jurisdiction. Do not resume operations until directed by authority.
- C. Conduct operations with minimum of interference to public or private access. Maintain ingress and egress at all times as noted on the drawings.
- D. Sprinkle work with water to minimize dust. Provide hoses and water connections for this purpose.
- E. Comply with governing regulations pertaining to environmental protection.

- F. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing prior to start of work.

3.3 DEMOLITION

- A. Demolish site improvements designated to be removed as shown on the drawings. Site improvements shall include but not be limited to structures, retaining walls, foundations, pavements, curbs and gutters, drainage structures, utilities, signage or landscaping.
- B. Disconnect and cap or remove utilities to be abandoned as shown on the drawings.
- C. Remove structures, piping, and appurtenances as shown.
- D. Demolish paving, curbs and remaining structures completely and remove from site using methods as required to complete work within limitations of governing regulations. Small structures may be removed intact when acceptable to Owner and authorities having jurisdiction.
- E. Locate demolition equipment and remove materials to prevent excessive loading to supporting walls, floors, or framing.
- F. Demolish concrete and masonry in small sections. Break up concrete slabs-on-grade that are 2-feet or more below proposed subgrade to permit moisture drainage. Remove slabs-on-grade and below grade construction within 2-feet of proposed subgrade.

3.4 FILLING VOIDS

- A. Completely fill below grade areas and voids resulting from demolition or removal of structures, underground fuel storage tanks, wells, cisterns, etc., using aggregate fill materials consisting of stone, gravel, or sand free from debris, trash, frozen materials, roots, and other organic matter.
- B. Areas to be filled shall be free of standing water, frost, frozen or unsuitable material, trash, and debris prior to fill placement.
- C. Place fill materials in accordance with Section 31 23 23 unless subsequent excavation for new work is required.
- D. Grade surface as shown on plans to match adjacent grades and to provide flow of surface drainage after fill placement and compaction.

3.5 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove from site debris, rubbish, and other materials resulting from demolition operations. Leave areas of work in clean condition.
- B. No burning of any material, debris, or trash on-site or off-site will be allowed, except when allowed by appropriate governing authority and Owner. If allowed as stated above, burning shall be performed in manner prescribed by governing authority. Attend burning materials until fires have burned out and have been completely extinguished.
- C. Transport materials removed from demolished structures with appropriate vehicles and dispose off-site to areas that are approved for disposal by governing authorities and appropriate property owners.

END OF SECTION 02 41 00

**SECTION 03 20 00
CONCRETE REINFORCING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Reinforcing steel for cast-in-place concrete.
- B. Welded-wire reinforcement.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 32 13 13 - Concrete Paving.

1.3 REFERENCE STANDARDS

- A. ACI CODE-318 - Building Code Requirements for Structural Concrete and Commentary; 2019 (Reapproved 2022).
- B. ACI SPEC-117 - Specification for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).
- C. ACI MNL-66 - ACI Detailing Manual; 2020.
- D. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
- E. ASTM A706/A706M - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement; 2022a.
- F. ASTM A970/A970M - Standard Specification for Headed Steel Bars for Concrete Reinforcement; 2018.
- G. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2022.
- H. ASTM D3963/D3963M - Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars; 2021.
- I. AWS D1.4/D1.4M - Structural Welding Code - Steel Reinforcing Bars; 2018, with Amendment (2020).
- J. CRSI (DA4) - Manual of Standard Practice; 2023.
- K. CRSI's "Manual of Standard Practice" - CRSI's "Manual of Standard Practice"; 2023.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: For the following:
 - 1. Each type of steel reinforcement.
 - 2. Bar supports
- C. Shop Drawings: Comply with requirements of ACI MNL-66
 - 1. Include placing drawings that detail fabrication, bending, and placement.
 - 2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, locations of splices, lengths of lap splices, details of mechanical splice couplers, details for welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Construction Joint Layout: Indicate proposed construction joints required to build the structure.
 - 1. Location of construction joints is subject to approval by Architect.
- E. Control Joint Layout: Indicated proposed control joints required to build the structure in slabs and walls.
 - 1. Location of control joints is subject to approval by Architect.

- F. Qualification Statements: For testing and inspection agency.
- G. Material Test Reports
- H. Steel Reinforcement:
 - 1. Field quality-control reports.
 - 2. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.
 - 3. Minutes of preinstallation conference.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review the following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Construction contraction and isolation joints.
 - c. Steel-reinforcement installation.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
 - 1. Store reinforcement to avoid contact with earth.

PART 2 PRODUCTS

2.1 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi), deformed.
- B. Headed-Steel Reinforcing Steel: ASTM A970/A970M.
- C. Deformed Bar Anchors: ASTM A1064/A1064M, Type C.
- D. Steel Welded Wire Reinforcement (WWR): Galvanized, deformed type; ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.2 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, 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 and welded-wire reinforcement in place.
 - 1. Fabricate concrete reinforcing in accordance with CRSI (DA4)- Manual of Standard Practice, of greater compressive strength than concrete as follows:
 - a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
- C. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 in diameter.
 - 1. Finish: Plain.

2.3 FABRICATION

- A. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice.
- B. Fabricate and handle epoxy-coated reinforcing in accordance with ASTM D3963/D3963M.

PART 3 EXECUTION

3.1 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Do not cut or puncture vapor retarder.
 - 2. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete
- C. Place, support and secure reinforcement against displacement. Do not deviate from required position.
- D. Do not displace or damage vapor barrier.
- E. Accommodate placement of formed openings.
- F. Comply with applicable code, including ACI CODE-318, for concrete cover over reinforcement.

3.2 INSTALLATION OF STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement.
 - 1. **Locate and support reinforcement with bar supports to maintain minimum concrete cover.** Do not position horizontal slab reinforcing by pulling on reinforcement during concrete placement.
 - 2. Do not tack weld crossing reinforcing bars.
- C. Preserve clearance between bars of not less than **1 inch**, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.
- D. Provide concrete coverage in accordance with ACI CODE-318.
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
 - 1. Stagger splices in accordance with ACI CODE-318.
 - 2. Weld reinforcing bars in accordance with AWS D1.4/D1.4M, where indicated on Drawings.
- G. Install welded-wire reinforcement in longest practicable lengths.
 - 1. Support welded-wire reinforcement in accordance with CRSI's "Manual of Standard Practice".
 - a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed **12 inches**.
 - 2. Lap edges and ends of adjoining sheets at least one wire spacing plus **2 inches** for plain wire and **8 inches** for deformed wire.
 - 3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
 - 4. Lace overlaps with wire.

3.3 JOINTS

- A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement.
 - 2. Continue reinforcement across construction joints unless otherwise indicated.
 - 3. Do not continue reinforcement through sides of strip placements of floors and slabs.
- B. 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.

3.4 INSTALLATION TOLERANCES

- A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
- C. Steel-reinforcement placement.
- D. Steel-reinforcement welding.
- E. Manufacturer's Inspections: Engage manufacturer of structural thermal break insulated connection system to inspect completed installations prior to placement of concrete, and to provide written report that installation complies with manufacturer's written instructions.

END OF SECTION 03 20 00

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Concrete formwork.
- B. Concrete for composite floor construction.
- C. Floors and slabs on grade.
- D. Concrete foundation walls.
- E. Concrete footings.
- F. Joint devices associated with concrete work.
- G. Miscellaneous concrete elements, including equipment pads, equipment pits, light pole bases, and manholes.
- H. Concrete curing.
- I. Site Retaining walls.
- J. Sheet vapor barrier under concrete slabs on grade.
- K. Water Stops

1.2 RELATED REQUIREMENTS

- A. Section 00 31 32 Geotechnical Report and General Foundation and Slab note sheet for drainage fill under slab-on-grade.
- B. Section 03 20 00 - Concrete Reinforcing.
- C. Section 03 35 11 - Concrete Floor Finishes: Densifiers, hardeners, applied coatings, and polishing.
- D. Section 07 21 00 - Thermal Insulation for under slab insulation.
- E. Section 07 92 00 - Joint Sealants: Products and installation for sealants and joint fillers for saw cut joints and isolation joints in slabs.
- F. Section 32 13 13 - Concrete Paving: Sidewalks, curbs and gutters.
- G. Section 00 31 32

1.3 REFERENCE STANDARDS

- A. AASHTO M 180 - Standard Specification for Steel Components for Highway Guardrail; 2023.
- B. ACI CODE-318 - Building Code Requirements for Structural Concrete and Commentary; 2019 (Reapproved 2022).
- C. ACI PRC-211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide; 2022.
- D. ACI PRC-302.1 - Guide to Concrete Floor and Slab Construction; 2015.
- E. ACI PRC-304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000 (Reapproved 2009).
- F. ACI PRC-305 - Guide to Hot Weather Concreting; 2020.
- G. ACI PRC-306 - Guide to Cold Weather Concreting; 2016.
- H. ACI PRC-308 - Guide to External Curing of Concrete; 2016.
- I. ACI PRC-347 - Guide to Formwork for Concrete; 2014 (Reapproved 2021).
- J. ACI SPEC-117 - Specification for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).
- K. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
- L. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2023.

- M. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2023.
- N. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2024.
- O. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens); 2023.
- P. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2020.
- Q. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
- R. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete; 2020.
- S. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a (Reapproved 2016).
- T. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2019, with Editorial Revision (2022).
- U. ASTM C618 - Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2023, with Editorial Revision.
- V. ASTM C989/C989M - Standard Specification for Slag Cement for Use in Concrete and Mortars; 2024.
- W. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 2021.
- X. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures; 2020.
- Y. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2022.
- Z. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction; 2012 (Reapproved 2022).
- AA. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Asphalt Types); 2023.
- BB. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2015 (Reapproved 2021).
- CC. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers; 2020.
- DD. ASTM E1155M - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers (Metric); 2014.
- EE. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2018a.
- FF. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017 (Reapproved 2023).
- GG. COE CRD-C 572 - Handbook for Concrete and Cement Corps of Engineers Specifications for Polyvinylchloride Waterstop; 1974.
- HH. PS 1 - Structural Plywood; 2023.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
 - 1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
 - 2. For membrane-forming, moisture emission-reducing, curing and sealing compound, provide manufacturer's installation instructions.
 - 3. Product Data for each of the Following:

- a. Portland cement.
 - b. Fly ash.
 - c. Silica fume.
 - d. Aggregates.
 - e. Admixtures:
 - 1) Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
 - f. Fiber reinforcement.
 - g. Waterstop.
 - h. Vapor retarders.
 - i. Curing materials.
 - j. Joint fillers.
 - k. Repair materials.
- C. Mix Design: Submit proposed concrete mix design.
- 1. Indicate proposed mix design complies with requirements of ACI SPEC-301, Section 4 - Concrete Mixtures.
 - 2. Indicate proposed mix design complies with requirements of ACI CODE-318, Chapter 5 - Concrete Quality, Mixing and Placing.
 - 3. For each concrete mixture, include the following:
 - a. Mixture identification.
 - b. Minimum 28-day compressive strength.
 - c. Maximum w/cm.
 - d. Slump limit.
 - e. Air content.
 - f. Nominal maximum aggregate size.
 - g. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
 - h. Intended placement method.
 - i. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- D. Shop Drawings:
- 1. Concrete Formwork: Indicate pertinent dimensions, materials, bracing, and arrangement of joints and ties.
 - 2. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - a. Location of construction joints is subject to approval of the Architect.
- E. Samples: Submit samples of underslab vapor retarder to be used.
- F. Samples: Submit one, 12 inch long samples of waterstops and construction joint devices.
- G. Test Reports: Submit report for each test or series of tests specified.

1.5 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI SPEC-301 and ACI CODE-318.
- 1. **Follow requirements of "Section 6 - Architectural Concrete" for all construction exposed to view.**

- B. Follow recommendations of ACI PRC-305 when concreting during hot weather.
- C. Follow recommendations of ACI PRC-306 when concreting during cold weather.

1.6 MOCK-UPS

- A. Construct and erect mock-up for architectural concrete surfaces indicated to receive special treatment or finish as result of formwork.
 - 1. Type: Stand alone mock-up.
 - 2. Size: As indicated on Drawings.
- B. Accepted mock-up panel is considered basis of quality for the finished work. Keep mock-up exposed to view for duration of concrete work.

PART 2 PRODUCTS

2.1 FORMWORK

- A. Formwork Design and Construction: Comply with guidelines of ACI PRC-347 to provide formwork that will produce concrete complying with tolerances of ACI SPEC-117.
 - 1. Design and construct concrete that complies with design with respect to shape, lines, and dimensions.
- B. Board-Formed Finish Concrete: Rough cedar boards that will provide distinctive wood grain pattern. Furnish 2x4 boards in 8 foot lengths.
- C. 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.
 - 1. Form Facing for Exposed Finish Concrete: Provide continuous, true, smooth, and stain-free final appearance.
 - a. Plywood, metal, or other approved panel materials.
 - b. 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.
 - c. Overlaid Finnish birch plywood.
 - d. Furnish in largest practicable sizes to minimize number of joints.
- D. Form Facing for Encapsulated Finish Concrete: Plywood, lumber, metal, form liners or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
 - 1. Where not exposed to view.
- E. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.
- F. 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.
 - 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

- G. Chamfer Strips: Rigid plastic, or elastomeric rubber, 1/4 by 1/4 inch, minimum; nonstaining; in longest practicable lengths.
- H. Rustication Strips: Rigid plastic, or with sides beveled and back kerfed; nonstaining; in longest practicable lengths.

2.2 REINFORCEMENT MATERIALS

- A. Comply with requirements of Section 03 20 00.

2.3 CONCRETE MATERIALS

- A. Source Limitations:
 - 1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
 - 2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
 - 3. Obtain aggregate from single source.
 - 4. Obtain each type of admixture from single source from single manufacturer.
- B. Cement: ASTM C150/C150M, Type I - Normal / Type II - Moderate Portland type. Grey.
- C. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
- D. Fine and Coarse Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded.
 - 1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- E. Fly Ash: ASTM C618, Class C or F.
- F. Silica Fume: ASTM C1240, proportioned in accordance with ACI PRC-211.1.
- G. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

2.4 ADMIXTURES

- A. Air Entrainment Admixture: ASTM C260/C260M.
- B. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
 - 2. High Range Water Reducing and Retarding Admixture: ASTM C494/C494M Type G.
 - 3. High Range Water Reducing Admixture: ASTM C494/C494M Type F.
 - 4. Water Reducing and Retarding Admixture: ASTM C494/C494M Type D.
 - 5. Retarding Admixture: ASTM C494/C494M Type B.
 - 6. Water Reducing Admixture: ASTM C494/C494M Type A.

2.5 ACCESSORY MATERIALS

- A. Underslab Vapor Retarder:
 - 1. Sheet Material: ASTM E1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. Single-ply polyethylene is prohibited.
 - a. Not less than 15 mils thick.
 - 2. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations.
 - 3. 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. Carlisle Coatings & Waterproofing, Inc.

- b. Stego Industries, LLC.
- c. Tex-Trude.
- d. W. R. Meadows, Inc.
- B. Granular Fill: Clean mixture of crushed stone or crushed or un-crushed gravel; ASTM D448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.
- C. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.
- D. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 in accordance with ASTM D2240.
- E. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- F. Floor Slab Protective Covering: 8-feet- wide cellulose fabric.

2.6 BONDING AND JOINTING PRODUCTS

- A. Waterstops: PVC, complying with COE CRD-C 572, with factory installed metal eyelets for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BoMetals, Inc.
 - b. Greenstreak.
 - c. Paul Murphy Plastics Company.
 - d. Vinylex Corp.
 - 2. Configuration: Ribbed with center bulb.
 - 3. Size: 6 inches by 3/8 inch thick; non-tapered.
 - 4. Location: As indicated on the drawings.
- B. Waterstops: Non-swelling, non-expanding surface-applied strip gasket.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include.
 - 2. Dimensions: As indicated on Drawings.
 - 3. Location: As indicated on Drawings.
 - 4. Primer Adhesive: As recommended by Manufacturer.
- C. Slab Isolation Joint Filler: 1/2-inch thick, height equal to slab thickness, with removable top section forming 1/2-inch deep sealant pocket after removal.
 - 1. Products:
 - a. Nomaco, Inc; Fastflex Slab Isolation Joint Filler with Tear-Off Strip: www.nomaco.com/#sle.
 - b. W. R. Meadows, Inc; Deck-O-Foam Joint Filler with pre-scored top strip: www.wrmeadows.com/#sle.
- D. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with rectangular or round knockout holes for conduit or rebar to pass through joint form at 6 inches on center; ribbed steel stakes for setting.

2.7 CURING MATERIALS

- A. Evaporation Reducer: Waterborne, liquid thin-film-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended for application immediately after concrete placement.

- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.
 - 1. Color:
 - a. Ambient Temperature Below 50 deg F: Black.
 - b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
 - c. Ambient Temperature Above 85 deg F: White.
- D. Curing and Sealing Compound, Low Gloss: Liquid, membrane-forming, clear, non-yellowing acrylic; complying with ASTM C1315, Type 1, Class A.
 - 1. Vehicle: Water-based.
 - 2. Verify compatibility with Section 03 35 43 - Concrete Polishing. Provide Curing Compound remover when compound is not compatible with concrete polishing system.
- E. Water: Potable, not detrimental to concrete.

2.8 CONCRETE MIX DESIGN

- A. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI SPEC-301.
 - 1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- B. Admixtures: Add acceptable admixtures as recommended in ACI PRC-211.1 and at rates recommended or required by manufacturer.
- C. Normal Weight Concrete:
 - 1. Fly Ash or Other Pozzolans Content: Maximum 25 percent of cementitious materials by weight.
 - 2. Slag Cement Content: Maximum 50 percent of cementitious materials by weight.
 - 3. Silica Fume Content: Maximum 10 percent of cementitious materials by weight.
 - 4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by weight, with fly ash or pozzolans not exceeding 25 percent by weight, and silica fume not exceeding 10 percent by weight.
 - 5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by weight with fly ash or pozzolans not exceeding 25 percent by weight, and silica fume not exceeding 10 percent by weight.
- D. Admixtures:
 - 1. Use admixtures in accordance with manufacturer's written instructions.
 - 2. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - 3. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 4. Use water-reducing admixture in pumped concrete, and concrete with a w/cm below 0.50.
 - 5. Water-Cement Ratio: Maximum 40 percent by weight.
 - 6. Maximum Aggregate Size: 5/8 inch.

2.9 MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M, and furnish batch ticket information.
- B. Adding Water: If concrete arrives on-site with slump less than suitable for placement, do not add water that exceeds the maximum water-cement ratio or exceeds the maximum permissible slump.

2.10 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic 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 or coarse sand, as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 4000 psi at 28 days when tested in accordance with ASTM C109/C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
 - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
 - 4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.
- C. **Do not parge coat concrete exposed to view.**

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify lines, levels, and dimensions before proceeding with work of this section.
- B. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Formwork: Comply with requirements of ACI SPEC-301. Design and fabricate forms to support all applied loads until concrete is cured and for easy removal without damage to concrete.
 - 1. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI SPEC-117.
 - 2. Chamfer exterior corners and edges of permanently exposed concrete as indicated on Drawings.
- B. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- C. Vapor Retarder: Install vapor retarder under interior slabs on grade. Comply with ASTM E1643. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.
 - 1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
 - 2. Face laps away from exposed direction of concrete pour.

3. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
4. Protect vapor retarder during placement of reinforcement and concrete.
 - a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.
- D. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

3.3 PLACING CONCRETE

- A. Place concrete in accordance with ACI PRC-304.
- B. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- C. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

3.4 FINISHING FORMED SURFACES

- A. Board Formed Finish: Apply the following to board formed concrete where indicated:
 1. Exposed concrete with rough cedar board formed face. Forms composed of 8 ft long 2x4 planks. Set joints offset 36". Set boards to finish with full width board at top.
- B. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
 1. Smooth-Rubbed Finish: Remove forms after concrete is set but not appreciably hardened. Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not coat surfaces or apply any grout to the face of concrete. Comply with ACI 301-96 for Rubbed Finish.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.5 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. 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 indicated.
- 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 indicated.
 2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-foot- long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/8 inch
- D. Broom Finish: Apply broom finish to exterior concrete walks, pads and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application
2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.-long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch.

3.6 FORM REMOVAL AND CLEANING

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
- B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- C. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.
- D. Clean forms as erection proceeds, to remove foreign matter within forms.
 1. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

3.7 SLAB JOINTING

- A. Locate joints as indicated on drawings.
- B. Anchor joint fillers and devices to prevent movement during concrete placement.
- C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
- D. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch thick blade and cut at least 1 inch deep but not less than one quarter (1/4) the depth of the slab.
 1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.
- E. Construction Joints: Where not otherwise indicated, use metal combination screed and key form, with removable top section for joint sealant.
 1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
 2. Place joints perpendicular to main reinforcement.
 - a. Continue reinforcement across construction joints unless otherwise indicated.
 - b. Do not continue reinforcement through sides of strip placements of floors and slabs.
 3. Space vertical joints in walls at two times wall height unless otherwise indicated on Drawings. Locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
 4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 5. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

- F. Isolation Joints in Slabs-on-Ground: 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 on Drawings.
 - 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
 - 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- G. Doweled Joints:
 - 1. Install dowel bars and support assemblies at joints where indicated on Drawings.
 - 2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

3.8 FLOOR FLATNESS AND LEVELNESS TOLERANCES

- A. An independent testing agency, as specified in Section 01 40 00, will inspect finished slabs for compliance with specified tolerances.
- B. Maximum Variation of Surface Flatness:
 - 1. Exposed Concrete Floors: 1/4 inch in 10 feet.
 - 2. Under Seamless Resilient Flooring: 1/4 inch in 10 feet.
 - 3. Under Carpeting: 1/4 inch in 10 feet.
- C. Correct the slab surface if tolerances are less than specified.
- D. Minimum F(F) Floor Flatness and F(L) Floor Levelness Values:
 - 1. Exposed to View and Foot Traffic: F(F) of 20; F(L) of 15, on-grade only.
 - a. Floor Flatness Overall Value (Ff) - 35
 - 1) Floor Flatness Local Value (Ff) - 24
 - b. Floor Levelness Overall Value (FI) - 25
 - 1) Floor Levelness Local Value (FI) - 17
- E. Measure F(F) Floor Flatness and F(L) Floor Levelness in accordance with ASTM E1155 (ASTM E1155M), within 48 hours after slab installation; report both composite overall values and local values for each measured section.
- F. 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.

3.9 CONCRETE FINISHING

- A. Repair surface defects, including tie holes, immediately after removing formwork.
- B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.
- C. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Provide finish as follows:
 - 1. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal.
- D. Concrete Slabs: Finish to requirements of ACI PRC-302.1 and as follows:
 - 1. Surfaces to Receive Thick Floor Coverings: "Wood float" as described in ACI PRC-302.1; thick floor coverings include quarry tile, ceramic tile, and Portland cement terrazzo with full bed setting system.

2. Surfaces to Receive Thin Floor Coverings: "Steel trowel" as described in ACI PRC-302.1; thin floor coverings include carpeting, resilient flooring, seamless flooring, resinous matrix terrazzo, thin set quarry tile, and thin set ceramic tile.
3. Decorative Exposed Surfaces: Trowel as described in ACI PRC-302.1; take measures necessary to avoid black-burnish marks; decorative exposed surfaces include surfaces to receive liquid hardeners, surfaces to receive dry-shake hardeners, and surfaces to be polished.
4. Other Surfaces to Be Left Exposed: Trowel as described in ACI PRC-302.1, minimizing burnish marks and other appearance defects.
- E. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1:100 nominal.
- F. Concrete Polishing: See Section 03 35 11.

3.10 CURING AND PROTECTION

- A. Comply with requirements of ACI PRC-308. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

3.11 FORMWORK TOLERANCES

- A. Construct formwork to maintain tolerances required by ACI SPEC-117, unless otherwise indicated.
- B. Camber slabs and beams in accordance with ACI SPEC-301.

3.12 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Submit proposed mix design of each class of concrete to testing firm for review prior to commencement of concrete operations.
- D. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.
- E. Compressive Strength Tests: ASTM C39/C39M, for each test, mold and cure **four** concrete test cylinders. Obtain test samples for every **100 cubic yards** or less **of each class** of concrete placed.
- F. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
- G. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M.
- H. Slab Testing: Cooperate with manufacturer of specified moisture vapor reducing admixture (MVRA) to allow access for sampling and testing concrete for compliance with warranty requirements.

3.13 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 complying with 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.

- E. Do not parge coat concrete exposed to view.

3.14 PROTECTION

- A. Do not permit traffic over unprotected concrete floor surface until fully cured.
- B. Protect concrete floor surface after grinding and polishing until final cleaning.

END OF SECTION 03 30 00

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SECTION 03 35 43
POLISHED CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Polished concrete system.
- B. Surface treatments for concrete floors and slabs.
- C. Densifiers and hardeners.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Finishing of concrete surface; curing.
- B. Section 07 92 00 - Joint Sealants.

1.3 REFERENCE STANDARDS

- A. ASTM D4039 - Standard Test Method for Reflection Haze of High-Gloss Surfaces; 2009 (Reapproved 2023).
- B. ASTM D5767 - Standard Test Method for Instrumental Measurement of Distinctness-of-Image (DOI) Gloss of Coated Surfaces; 2018 (Reapproved 2023).

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate work of this section with concrete floor placement and concrete floor curing.
- B. Preinstallation Meeting: Conduct a preinstallation meeting 10 days prior to start of work of this section.
 - 1. Items for Review:
 - a. Physical requirements of completed concrete slab and slab finish.
 - b. Location and timing of test areas.
 - c. Protection of surfaces not scheduled for finish application.
 - d. Surface preparation.
 - e. Application procedure and quality control.
 - f. Cleaning and protection of finish.
 - g. Coordination with other work.
 - 2. Require attendance of parties directly affecting work of this section, including:
 - a. Concrete installer.
 - b. Finish installer.
 - c. Contractor's representative.
 - d. Architect.
 - 3. Notify parties one week in advance of date and time of meeting.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's published data on each finishing product, including information on compatibility of different products and limitations.
- C. Product Data: Manufacturer's published data and installation instructions for concrete polishing system and finishing products, including manufacturer's installation instructions, information on compatibility of different products, and limitations.
- D. Product Data: Submit certification that products comply with regulations controlling use of volatile organic compounds.

- E. Maintenance Data: Provide data on maintenance and renewal of applied finishes.
- F. Installer's qualification statement.
- G. Executed warranty.

1.6 QUALITY ASSURANCE

- A. Comply with national, state, and local VOC regulations.
- B. Installer Qualifications:
 - 1. Company specializing in installing products specified in this section, having completed minimum of five projects of similar size and complexity.
 - 2. Company specializing in installing products specified in this section, having a minimum of **five years** experience in performing work of this section.
 - 3. Company is listed applicator of concrete finishes, having completed manufacturer's training program.

1.7 MOCK-UP

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. For coatings, construct mock-up area under conditions similar to those that will exist during application, with coatings applied.
- C. Mock-Up Size: 50 sq ft.
- D. Locate on site where directed.
- E. Accepted mock-up panel is considered basis of quality for the finished work. Keep mock-up exposed to view for duration of concrete work.
- F. Mock-up may remain as part of work.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's sealed packaging, including application instructions.
- B. Store materials per manufacturer's product data sheets:
 - 1. Store containers upright in cool, dry, well-ventilated place, out of the sun, at temperature between 40 degrees F and 100 degrees F.
 - 2. Store away from other chemicals and potential sources of contamination.
 - 3. Keep containers tightly closed when not in use.

1.9 FIELD CONDITIONS

- A. Ambient Conditions:
 - 1. Apply treatments and coatings when surface and air temperature is between 40 degrees F and 95 degrees F.
 - 2. Apply treatments and coatings when surface and air temperature is expected to remain above 40 degrees F for a minimum of eight hours after application.
 - 3. Maintain ambient temperature of 50 degrees F minimum.
 - 4. Apply treatments and coatings during calm wind conditions; provide adequate ventilation of enclosed or confined area.
 - 5. Apply treatments and coatings minimum 24 hours after rain exposure; suspend application when rain is anticipated within 8 hours of application.
 - 6. Do not apply to frozen substrate. Allow adequate time for substrate to thaw, if freezing conditions exist before application.

7. Temporary Lighting: Minimum 200 W light source, placed 8 feet (2.5 m) above horizontal concrete surface, for each 425 square feet (40 sq m) of concrete being finished.
8. Temporary Heat: Ambient temperature of 50 degrees F (10 degrees C) minimum.
9. Ventilation: Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with manufacturer's instructions.

1.10 WARRANTY

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

PART 2 PRODUCTS

2.1 PERFORMANCE GUIDELINES

- A. Testing Criteria: High tolerance hardened concrete floor finish shall comply with the following performance requirements.
 1. Performance Characteristics:
 - a. aADA Coefficient of Friction: Meets or exceeds ADA COF of 0.60 for accessible routes and 0.80 for ramps tested in accordance with ASTM C 1028.
 - b. Degree of Reflectiveness as per horizontal test area tested in accordance with ASTM E 430. Increase of 35% as determined by standard gloss meter
 - c. Degree of Hardness as per horizontal test area tested in accordance with ASTM D 3363-05.
 - d. Measure of Water Absorption as per horizontal test area tested in accordance with Rilem Test Method – Test No. 11.4 – 70% or greater reduction in absorption.
- B. Appearance Expectations:
 1. Aesthetics:
 - a. Aggregate Exposure: Class B (85 - 95% Fine Aggregate and 5 - 15% Blend of Cement Fines and Coarse Aggregate) - Salt/Pepper Finish. Expose the fine aggregate such as sand and small aggregate with the concrete. The depth of grind will depend greatly on the placement and finishing procedures. Generally, this level of cut can be achieved within 1/16" of the surface. Exposure of coarse aggregate must be approved by the Architect based on the Test Area.
 - b. Color: Uniform and even as approved in Test Area.
 2. Quantitative
 - a. Gloss Level: Level 3 Sheen (semi-gloss) as determined by a gloss reading of 50-60.
 - b. Mohs Hardness: 5.5+
 - c. Slip Resistance: 0.60
 - d. Water Resistance: maintain level for 20 minutes

2.2 POLISHED CONCRETE SYSTEM

- A. Polished Concrete System: Materials, equipment, and procedures designed and furnished by a single manufacturer to produce dense polished concrete of the specified sheen.
 1. Basis of Design Product: Provide; Consolideck Polished Concrete System: as manufactured by PROSOCO: www.prosoco.com/consolideck/#sle, or comparable product of other manufacturers approved by the Architect.
 2. Substitutions: See Section 01 25 00 - Substitution Procedures.

2.3 SURFACE TREATMENTS

- A. Cutting Aid: Clear, water-based blended surfactant treatment spray-applied to wet concrete.
 - 1. VOC Content: 0.5 g/L or less.
- B. Repair Material: Low-odor, liquid fill material.
 - 1. VOC Content: 100 g/L or less.
- C. Cleaner: Pre-densifier concrete cleaner for existing slab surfaces.

2.4 DENSIFIERS AND HARDENERS

- A. Description: Penetrating chemical compound, reacts with concrete, filling pores, hardening, and dustproofing. Clear, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and is suitable for polished concrete surfaces.
 - 1. Basis of Design Product: Provide DenseKure as manufactured by PROSOCO:
www.prosoco.com/consolideck/#sle, or comparable product of other manufacturers approved by the Architect.
 - a. UV Stability: No degradation or yellowing when tested in accordance with ASTM G154.

2.5 PROTECTIVE TREATMENTS

- A. Description: High-gloss penetrating premium sealer, lithium silicate hardener for horizontal concrete surfaces including cement terrazzo. Treated surfaces resist damage from water, chemical attack and abrasion.
 - 1. Basis of Design Product: Provide Consolideck BD1 as manufactured by PROSOCO:
www.prosoco.com/consolideck/#sle, or comparable product of other manufacturers approved by the Architect.

2.6 MAINTENANCE CLEANING PRODUCTS

- A. Description: A concentrated maintenance cleaner for concrete floors with lithium silicate component to help maintain concrete hardness by curing any "soft" calcium hydroxide left over from the original hardening-densifying treatment.. Biodegradable, environmentally safe and certified High Traction by National Floor Safety Institute (NFSI).
 - 1. Basis of Design Product: Provide Consolideck Klean as manufactured by PROSOCO:
www.prosoco.com/consolideck/#sle, or comparable product of other manufacturers approved by the Architect.

2.7 BURNISHING EQUIPMENT

- A. High speed burnisher manufacturer.
 - 1. Manufacturer:
 - a. Eagle Solutions or approved equal.

2.8 ADDITIONAL EQUIPMENT

- A. Pump sprayer and tip.
 - 1. Pump compatible for solvent for SLX100
 - 2. Pump compatible for water based material
 - 3. Tip size not to exceed 0.5 GPM
- B. Airless.
 - 1. Produces 0.47 GPM, equivalent to GRACO 390 with 4 or 611 tip and Extended Reach Tools.
- C. Microfiber mop with wet pads
- D. Soft bristle broom

2.9 ENVIRONMENTAL EQUIPMENT

- A. Applicator is to submit Environmental Plan in accordance with local regulatory requirements. Permits or notice from local regulatory accepting and acknowledging method of disposal of waste.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that floor surfaces are clean and free of previous coatings, sealers, curing compounds, water repellents, laitance, efflorescence, fats, oils, grease, wax, soluble salts, residues from cleaning agents, and other impediments to adhesion.
- B. Verify that flaws in concrete have been patched and joints filled with methods and materials suitable for further finishes and allow complete curing before application of concrete hardener and densifier. See Section 07 92 00.

3.2 GENERAL

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

3.3 PREPARATION

- A. Protect adjacent non-coated areas from drips, overflow, and overspray; avoid contact with metal, glass, and painted surfaces; immediately remove excess material.
- B. Clean dirt, dust, oil, grease and other contaminants from surfaces that interfere with penetration or performance of specified product. Use appropriate concrete cleaners approved by the concrete surface treatment manufacturer where necessary. Rinse thoroughly using pressure water spray to remove cleaner residues. Allow surfaces to dry completely before application of product.
- C. Utilize appropriate Surface Preparation Cleaner products as dictated by conditions found onsite.
- D. Repair, patch and fill cracks, voids, defects and damaged areas in surface as approved by the Architect prior to patching and repair. Allow repair materials to cure completely before application of product.
- E. Variations in substrate texture and color will affect final appearance and should be corrected prior to application of sealer/hardener system and the polishing steps.
- F. Avoid contact in areas not to be treated. Avoid contact with metal, glass and painted surfaces.
- G. Apply specified Control Joint Filler.
- H. After floor has been finished apply specified sealants to isolation and expansion joints

3.4 CONCRETE POLISHING

- A. Grind and polish in multiple passes with each full pass in direction perpendicular to previous pass.
- B. Fill gaps, voids, and pop-outs during grinding operation.
- C. Apply densifier and hardener at specified rates and intervals.
- D. **Final Polished Concrete Aggregate Exposure:** Not to exceed CPC Class B - Fine Aggregate; fine aggregates, 85 to 95 percent; cement fines and coarse aggregate blend, 5 to 15 percent based on visual observation of overall area of polished floor versus Polished Concrete Aggregate Exposure Chart.
 - 1. The depth of grind will depend greatly on the placement and finishing procedures. Generally, this level of cut can be achieved within 1/8" of the surface.
 - 2. Exposure of aggregate must be approved by the Architect based on Mock Up.
 - 3. Uniform and even color, as approved in Mock Up.
- E. **Final Polished Concrete Appearance:** CPC Level 3 - Polished, image clarity value 40 to 69 percent with haze index less than 10.

- F. Mohs Hardness: 5.5+
- G. Slip Resistance: **Not less than 0.60 on flat surfaces and 0.80 on ramps.**
- H. Water Resistance: maintain level for 20 minutes

3.5 PROTECTIVE TREATMENT

- A. Apply coatings in accordance with manufacturer's instructions. Match approved mock-ups for color, texture, sealing, and workmanship.
- B. Apply manufacturer's recommended protective treatment material to clean, dry slab after mechanically polishing.
- C. Clean spills on slab surfaces immediately, with manufacturer's recommended chemicals and absorptive materials.
- D. No haze, white residue, streaking, or burnish marks permitted.

3.6 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Final Polished Concrete Appearance: Test image clarity value and haze index prior to application of sealer at a rate of three tests per 1000 sq ft of polished concrete.
 - 1. Image clarity: Test with Image Clarity Meter in accordance with ASTM D5767.
 - 2. Haze index: Test with Glossmeter in accordance with ASTM D4039.
 - 3. Match approved mock-ups for texture, appearance, and workmanship.

3.7 TOLERANCES

- A. Allowable differences from "test area standards":
 - 1. Gloss: Less than 10 percent.
 - 2. Hardness: Less than 10 percent.
 - 3. Slip Resistance (COF): Not less than Americans with Disabilities Act (ADA) requirements.
 - 4. Rilem Tube: Less than 1 ml loss.

3.8 FINAL CLEANING

- A. Clean site of all unused product, residues, rinse water, wastes, and effluents in accordance with environmental regulations.
- B. Remove and dispose of all materials used to protect surrounding areas following completion of the work of this section.
- C. Repair, restore or replace to the satisfaction of the Architect, all surfaces damaged by exposure to the work of this section.
- D. Run auto-scrubber over surface with cleaning product diluted 4 oz. to one gallon of water.
- E. Over entire surface run high-speed burnisher with appropriate Norton Abrasive pad. If areas have blemishes or scuff marks use a 1:1 diluted solution of protective treatment sprayed in front of burnisher. Confirm temperature as above.

3.9 PROTECTION

- A. Do not permit traffic over unprotected concrete floor surface until fully cured.

END OF SECTION 03 35 43

SECTION 04 20 00
UNIT MASONRY

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Concrete block.
- B. Mortar and grout.
- C. Reinforcement and anchorage.
- D. Flashings.
- E. Lintels.
- F. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 04 22 23 - Architectural Concrete Unit Masonry: Installation of Decorative CMU to masonry back-up.
- B. Section 04 43 13 - Stone Masonry Veneer: Stone bonded to masonry back-up.
- C. Section 07 21 00 - Thermal Insulation: Insulation for cavity spaces.
- D. Section 07 27 26 Fluid-applied Membrane Air barriers applied to exterior face of backing sheathing or unit masonry substrate.
- E. Section 07 62 00 - Sheet Metal Flashing and Trim: Through-wall masonry flashings.
- F. Section 07 92 00 - Joint Sealants: Sealing control and expansion joints.

1.3 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- B. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2023a.
- C. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
- D. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2019.
- E. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.
- F. ASTM A951/A951M - Standard Specification for Steel Wire for Masonry Joint Reinforcement; 2022.
- G. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2022.
- H. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units; 2023.
- I. ASTM C91/C91M - Standard Specification for Masonry Cement; 2023.
- J. ASTM C140/C140M - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units; 2023a.
- K. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar; 2018.
- L. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
- M. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes; 2018.
- N. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2019a, with Editorial Revision.
- O. ASTM C404 - Standard Specification for Aggregates for Masonry Grout; 2024.
- P. ASTM C476 - Standard Specification for Grout for Masonry; 2023.

- Q. ASTM C780 - Standard Test Methods for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry; 2023.
- R. ASTM D226/D226M - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing; 2017 (Reapproved 2023).
- S. BIA Technical Notes No. 7 - Water Penetration Resistance – Design and Detailing; 2017.
- T. BIA Technical Notes No. 13 - Ceramic Glazed Brick Exterior Walls; 2017.
- U. BIA Technical Notes No. 28B - Brick Veneer/Steel Stud Walls; 2005.
- V. BIA Technical Notes No. 46 - Maintenance of Brick Masonry; 2017.
- W. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures; 2022, with Errata (2024).

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.

PART 2 PRODUCTS

2.1 CONCRETE MASONRY UNITS

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

2.2 MORTAR AND GROUT MATERIALS

- A. Masonry Cement: ASTM C91/C91M, Type S.
- B. Portland Cement: ASTM C150/C150M, Type I; color as required to produce approved color sample.
 - 1. Not more than 0.60 percent alkali.
- C. Hydrated Lime: ASTM C207, Type S.
- D. Mortar Aggregate: ASTM C144.
- E. Grout Aggregate: ASTM C404.
- F. Water: Clean and potable.

2.3 REINFORCEMENT AND ANCHORAGE

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi), deformed billet bars; uncoated.
- B. Joint Reinforcement: Use ladder type joint reinforcement where vertical reinforcement is involved and truss type elsewhere, unless otherwise indicated.
- C. Single Wythe Joint Reinforcement: ASTM A951/A951M.
 - 1. Type: Truss or ladder.
 - 2. Material: ASTM A1064/A1064M steel wire, mill galvanized to ASTM A641/A641M Class 3.
 - 3. Size: 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not less than 5/8 inch of mortar coverage on each exposure.

- D. Multiple Wythe Joint Reinforcement: ASTM A951/A951M.
 - 1. Type: Truss.
 - 2. Material: ASTM A1064/A1064M steel wire, mill galvanized to ASTM A641/A641M Class 3.
 - 3. Size: 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not less than 5/8 inch of mortar coverage on each exposure.
- E. Adjustable Multiple Wythe Joint Reinforcement: ASTM A951/A951M.
- F. Flexible Anchors: 2-piece anchors that permit differential movement between masonry and building frame, sized to provide not less than 5/8 inch of mortar coverage from masonry face.
 - 1. Concrete frame: Dovetail anchors of bent steel strap, nominal 1 inch width x 0.024 in thick, with trapezoidal wire ties 0.1875 inch thick, hot dip galvanized to ASTM A 153/A 153M, Class B.
- G. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B.
 - 1. Anchor plates: Not less than 0.075 inch thick, designed for fastening to structural backup through sheathing by two fasteners; provide design with legs that penetrate sheathing and insulation to provide positive anchorage.
 - 2. Wire ties: Manufacturer's standard shape, 0.1875 inch thick.
 - 3. Vertical adjustment: Not less than 3-1/2 inches.

2.4 FLASHINGS

- A. Metal Flashing Materials:
 - 1. Stainless Steel Flashing: ASTM A666, Type 304, soft temper; 26 gauge, 0.0187 inch thick; finish 2B to 2D.
 - 2. Prefabricated Metal Flashing: Smooth fabricated 12 oz/sq ft stainless steel (type 304) flashing for surface mounted conditions.
- B. Combination Non-Asphaltic Flashing Materials - Stainless Steel:
 - 1. Stainless Steel/Polymer Fabric Flashing: ASTM A240/A240M; 2 mil type 304 stainless steel sheet bonded on one side to one sheet of polymer fabric.

2.5 ACCESSORIES

- A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.
- B. Joint Filler: Closed cell rubber; oversized 50 percent to joint width; self expanding; in maximum lengths available.
- C. Cavity Mortar Control: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage.
 - 1. Mortar Diverter: Semi-rigid mesh designed for installation at flashing locations.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Advanced Building Products Inc; Mortar Break: www.advancedbuildingproducts.com/#sle.
 - 2) Mortar Net Solutions; MortarNet: www.mortarnet.com/#sle.
- D. Building Paper: ASTM D226/D226M, Type I ("No.15") asphalt felt.
- E. Weeps:
 - 1. Type: Extruded propylene with honeycomb design.
 - 2. Color(s): As selected by Architect from manufacturer's full range.

- F. Cavity Vents:
 - 1. Type: Extruded propylene with honeycomb design.
 - 2. Color(s): As selected by Architect from manufacturer's full range.
- G. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.6 LINTELS

- A. Prefabricated Steel Lintels:

2.7 MORTAR AND GROUT MIXING

- A. Mortar for Unit Masonry: ASTM C270, using the Proportion Specification.
 - 1. Masonry below grade and in contact with earth: Type M.
 - 2. Exterior, loadbearing masonry: Type N.
 - 3. Exterior, non-loadbearing masonry: Type N.
 - 4. Interior, loadbearing masonry: Type N.
 - 5. Interior, non-loadbearing masonry: Type O.
- B. Grout: ASTM C476; consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches.
- C. Admixtures: Add to mixture at manufacturer's recommended rate and in accordance with manufacturer's instructions; mix uniformly.
- D. Mixing: Use mechanical batch mixer and comply with referenced standards.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Direct and coordinate placement of metal anchors supplied for installation under other sections.
- B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.3 COURSING

- A. Establish lines, levels, and coursing indicated. Protect from displacement.
- B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- C. Concrete Masonry Units:
 - 1. Bond: Running.
 - 2. Coursing: One unit and one mortar joint to equal 8 inches.

3.4 PLACING AND BONDING

- A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- B. Lay hollow masonry units with face shell bedding on head and bed joints.
- C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- D. Remove excess mortar and mortar smears as work progresses.

- E. Interlock intersections and external corners.
- F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
- H. Cut mortar joints flush where wall tile is scheduled, resilient base is scheduled, cavity insulation vapor barrier adhesive is applied, or bitumen dampproofing is applied.
- I. Isolate masonry partitions from vertical structural framing members with a control joint as indicated.
- J. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

3.5 WEEPS/CAVITY VENTS

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

3.6 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.

3.7 REINFORCEMENT AND ANCHORAGE - GENERAL, SINGLE WYTHER MASONRY, AND CAVITY WALL MASONRY

- A. Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Embed longitudinal wires of joint reinforcement in mortar joint with at least 5/8 inch mortar cover on each side.
- E. Lap joint reinforcement ends minimum 6 inches.
- F. Reinforce stack bonded unit joint corners and intersections with strap anchors 16 inches on center.
- G. 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 horizontally and 24 inches vertically.

3.8 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER

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

3.9 MASONRY FLASHINGS

- A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
 - 1. Extend flashings full width at such interruptions and at least 6 inches, minimum, into adjacent masonry or turn up flashing ends at least 2 inches, minimum, to form watertight pan at nonmasonry construction.
 - 2. Remove or cover protrusions or sharp edges that could puncture flashings.
 - 3. Seal lapped ends and penetrations of flashing before covering with mortar.
- B. Terminate flashing up 8 inches minimum on vertical surface of backing:
 - 1. Install vertical leg of flashing over fluid-applied or self-adhered air/vapor barriers over backing or per manufacturer's directions.
 - 2. Terminate vertical leg of flashing into bed joint in masonry or reglet in concrete.
- C. Install flashing in accordance with manufacturer's instructions and BIA Technical Notes No. 7.
- D. Extend metal flashings through exterior face of masonry and terminate in a flat drip with hemmed edge. Install joint sealer below drip edge to prevent moisture migration under flashing. No exposed drip edge of metal flashing shall extend over the face of the masonry unless shown otherwise in the drawings.
- E. Lap end joints of flashings at least 6 inches, minimum, and seal watertight with flashing sealant/adhesive.

3.10 LINTELS

- A. Install loose steel lintels over openings.
- B. Install reinforced unit masonry lintels over openings where steel or precast concrete lintels are not scheduled.
- C. Maintain minimum 8 inch bearing on each side of opening.
- D. Install thermal veneer support system in accordance with manufacturer's instructions at locations indicated on drawings

3.11 GROUTED COMPONENTS

- A. Lap splices minimum 24 bar diameters.
- B. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
- C. Place and consolidate grout fill without displacing reinforcing.

3.12 CONTROL AND EXPANSION JOINTS

- A. Do not continue horizontal joint reinforcement through control or expansion joints.
- B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.
- C. Size control joints as indicated on drawings; if not indicated, 3/4 inch wide and deep.
- D. Form expansion joint as detailed on drawings.

3.13 BUILT-IN WORK

- A. As work progresses, install built-in metal door frames and glazed frames and other items to be built into the work and furnished under other sections.
- B. Install built-in items plumb, level, and true to line.
- C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
 - 1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
- D. Do not build into masonry construction organic materials that are subject to deterioration.

3.14 TOLERANCES

- A. Install masonry within the site tolerances found in TMS 402/602.
- B. Maximum Variation from Alignment of Columns: 1/4 inch.
- C. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
- D. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
- E. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
- F. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.
- G. Maximum Variation of Mortar Joint Thickness: Head joint, minus 1/4 inch, plus 3/8 inch.
- H. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.15 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.

3.16 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 compliance with requirements of this specification.
- C. Mortar Tests: Test each type of mortar in accordance with ASTM C780, testing with same frequency as masonry samples.

3.17 CLEANING

- A. Remove excess mortar and mortar droppings.
- B. Replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces with cleaning solution.
- D. Use non-metallic tools in cleaning operations.

3.18 PROTECTION

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

END OF SECTION 04 20 00

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SECTION 04 22 23
ARCHITECTURAL CONCRETE UNIT MASONRY

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Architecturally styled concrete masonry units.

1.2 RELATED SECTIONS

- A. Section 04 20 00 - Unit Masonry: Joint reinforcement, Ties, Anchors, and Through-wall flashing
- B. Section 07 21 13 - Board Insulation.
- C. Section 07 27 26 - Fluid-applied Membrane Air Barrier.
- D. Section 07 62 00 - Flashing and Sheet Metal.
- E. 07 92 00 - Joint Sealant

1.3 REFERENCES

- A. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units.
- B. ASTM C270 - Standard Specification for Mortar for Unit Masonry.
- C. ASTM C744 - Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units
- D. ASTM C1262 - Standard Test Method for Evaluating the Freeze-Thaw Durability of Dry-Cast Segmental Retaining Wall Units and Related Concrete Units
- E. ASTM C1714/C1714M - Standard Specification for Preblended Dry Mortar Mix for Unit Masonry.

1.4 DEFINITIONS

- A. CMU: Concrete Masonry Unit.
- B. Dimensions: All unit sizes are shown as Nominal Dimensions.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section.

1.6 SUBMITTALS

- A. See Section 01 30 00-Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's product information and data sheets for each product specified in this section, including:
 - 1. Substrate preparation instructions and recommendations.
 - 2. Installation means and methods.
 - 3. Recommendations and requirements for proper storage and handling.
- C. Shop Drawings:
 - 1. Submit Manufacturer's approved shop drawings detailing the section and elevation views of each product to be installed.
 - 2. Coordinate with locations listed on Contract Drawings.
 - 3. Reinforcing: Provide drawings indicating reinforcing that complies with ACI 315 "Details and Detailing of Concrete Reinforcement".
 - a. Provide elevations indicating steel reinforcing bar placement.
 - b. Provide details indicating steel reinforcing bar sizes, placement, bends, and laps dimensions.
- D. Warranty Information:

1. Submit confirmation and details of manufacturer's warranty, extended warranty, and replacement policies.
- E. Submit product data for each type of product specified, including certification that each type complies with specified requirements.
- F. Submit sample boards, cards or charts depicting available textures and colors for each CMU.
- G. Mock-Up: Construct a mock-up using the selected stone and mortar materials to illustrate the appearance of the Work specified in this section.
 1. The mock-up should be a nominal 36 inches x 36 inches (1m x 1m).
 2. Construct the mock-up using the size, color blend, texture, joint size, and installation methods specified.
 3. Architect and Owner's Representative must approve the mockup prior to commencement of Work.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver masonry materials to the site on quality wooden pallets with appropriate in-plant packaging for safe transit and handling. Store pallets in single stacks on level ground and protect from weather.
- B. Deliver mortar materials in original unbroken, undamaged packages with labels intact and visible.
- C. Store materials covered and off the ground until used on the Work in this section.

1.8 WARRANTY

- A. Provide a copy of the project specific manufacturer's warranty which addresses the term of the warranty period (in years), the acceptable standards of production/performance and the agreed upon action for products that fail to meet the standards of production/performance within the specified warranty period.
 1. Warranty period: _____ years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Manufacturer: Echelon, An Oldcastle Company; www.echelonmasonry.com.
- B. Substitutions: See Section 01 60 00 Product Requirements.

2.2 PERFORMANCE REQUIREMENTS

- A. Freeze-Thaw Resistance: Meet or exceed the requirements of ASTM C1262.
- B. Abrasion Resistance: Meet or exceed the requirements of ASTM C744.
- C. Adhesion: Meet or exceed the requirements of ASTM C744.
- D. Color Change: Meet or exceed the requirements of ASTM C744.
- E. Resistance to Cracking: Meet or exceed the requirements of ASTM C744.
- F. Fire Resistance: Rated up to (4) four hours.
- G. Integral Water Repellant: Concrete Masonry Units must include an integral water repellant admixture at the time of production.

2.3 CONCRETE MASONRY UNITS

- A. General / Appearance: Pre-finished, architectural concrete block meeting the requirements of ASTM C90. One or more faces are ground to emulate a smooth terrazzo finish. A factory-applied clear satin gloss acrylic enhances moisture resistance.
 1. Basis of Design Product: Trendstone Plus® concrete masonry units, from Echelon.

2.4 FINISHES

- A. Color:
 - 1. Color: Limestone
- B. Dimensions:
 - 1. CMU (WxHxD): 2'-8" inches x 8" inches x 4" inches. Locations and installation patterns as noted in the contract documents.

2.5 MORTAR

- A. Provide site-mixed mortar that meets or exceeds the requirements of ASTM C270 Type N.
- B. Provide pre-blended mortar that meets or exceeds the requirements of ASTM C1714/C1714M Type N.
- C. Mortar must include manufacturer approved compatible integral water repellent additive added to each batch in the dosage rates for mortar type specified.

2.6 MIXES

- A. Portland Cement: Conforming to ASTM C150 Type I, Type II or Type III as required to achieve optimal results based on ambient project conditions.
- B. Hydrated Lime: Conforming to ASTM C207, Type S.
- C. Aggregates: Conforming to ASTM C144 for mortar and ASTM C404 for grout.
- D. Pigments: Conforming to ASTM C979. Comply with quantity limitations in referenced standards and from the pigment manufacturer.
- E. Admixtures: Comply with quantity limitation specified ASTM C1384 "Standard Specification for Admixtures for Masonry Mortars" when adding to mortar.
 - 1. Cold Weather: Comply with ASTM C494 "Standard Specification for Chemical Admixtures for Concrete."
 - 2. Integral Water Repellant: Liquid polymeric, admixture that does not reduce flexural bond strength
 - a. Basis of Design Product: RainBloc® Water Repellent Masonry Unit admixture, manufactured by ACM Chemistries, Inc.
- F. Water: Potable; Clean and drinkable.

2.7 ACCESSORIES

- A. Provide coordinating accessory stones as necessary to achieve a complete installation as noted in the Contract Drawings.
- B. See Section 04 20 00 Unit Masonry for installation to masonry back-up.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that site conditions are properly prepared to receive concrete masonry units.
- B. Verify that bearing elements are within tolerances conforming to the requirements of ACI 117.
- C. Verify that locations of penetrations, projections and built-in items are correct and properly prepared for work specified in this section.
- D. Verify concrete brick masonry units are according to project specification and meet appropriate ASTM specification requirements. Commencement of installation constitutes acceptance of Concrete Face Brick, Concrete Masonry Units, Concrete Masonry Veneers, and Concrete Thin Veneers.
- E. Preparation: Prepare surfaces and materials in accordance with MSJC Specifications for Masonry Structures. If preparation is the responsibility of another installer, notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.

- F. Provide adequate lighting for masonry work by placing all lighting at a reasonable distance from the wall for even illumination.

3.2 PREPARATION

- A. Proceed with installation only after substrate(s) are been properly prepared and within tolerances recommended by the manufacturer.
- B. Commencement of installation constitutes acceptance of site conditions.
- C. Draw blocks from more than one pallet at a time during installation.
- D. Refer to NCMA TEK Notes, for hot and cold weather construction practices.

3.3 INSTALLATION

- A. Cutting: Make all unit cuts, including those for bonding, holes, boxes, etc., with motor-driven masonry saws, using either an abrasive or diamond blade. Cut neatly and locate for best appearance.
- B. Concrete Masonry Units:
 - 1. Install concrete masonry units in accordance with industry accepted masonry practices and manufacturer's instructions.
 - 2. Bond Pattern: As indicated on Construction Drawings.
 - 3. Do not use masonry units with broken corners and edges in excess of ASTM C90 and ASTM C1634.
 - 4. Supporting and Forms: Construct forms as needed to adequately and safely support installed concrete masonry units until mortar has cured.
- C. Mortar Bedding and Jointing:
 - 1. Lay units with full mortar coverage on head and bed joints taking care not to block cores to be grouted or filled with masonry insulation.
 - 2. Tool all joints into a concave configuration when mortar is thumbprint hard.
 - 3. Remove mortar from the face of masonry units before it sets.
 - 4. Tuckpoint joints of scored units for proper appearance and to prevent water penetration. Rake joints are not permitted and will be considered defective work.
- D. Flashing: Install flashing at locations shown in the plans and in strict accordance with Construction Drawings, manufacturer's instructions and accepted best practices for masonry flashing.
 - 1. See Section 04 20 00 – Unit Masonry.
- E. Weeps and Vents: Install weep holes and vents at proper intervals at courses above grade and at any water stops over windows, doors and beams. Consult NCMA TEK notes for proper flashing and drawings.
 - 1. See Section 04 20 00 – Unit Masonry.

3.4 FLASHING

- A. All flashing and accessory detailing components must be corrosion resistant.
- B. Verify that all flashing, including adjacent roof flashing, has been properly installed. Extend flashing material above horizontal terminations, roofing material, drainage planes or drainage products.
- C. Integrate all flashing materials with moisture resistive barriers to prevent water penetration into structure. Lap water resistive barriers over weep screed flanges in a water shedding fashion.
- D. Control Joints: Determine if and where Control joints are needed. Consideration should be given to where differential movement is expected or where movement may be concentrated. Refer to NCMA TEK 10-02C for guidance on control joint locations.
- E. See Section 04 20 00 – Unit Masonry.

3.5 INSPECTION AND CLEANING

- A. Faces must conform to the requirements of ASTM C90 when viewed from twenty (20) feet at right angles to the wall with normal lighting.
- B. Keep work surfaces clean during installation. Use brushes, rags and burlap to remove excess mortar lumps and smears prior to hardening on the finished surfaces.
- C. Refer to Manufacturers recommendations for cleaning instructions for installed veneers.

END OF SECTION 04 22 23

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SECTION 04 43 13
STONE MASONRY VENEER

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Anchored cut stone veneer at exterior walls.
- B. Metal anchors and accessories for anchored veneer.
- C. Setting mortar.

1.2 RELATED REQUIREMENTS

- A. Section 04 20 00 - Unit Masonry: Joint reinforcement, Ties, Anchors, and Through-wall flashing.
- B. Section 07 21 13 - Board Insulation.
- C. Section 07 27 26 - Fluid-applied Membrane Air Barrier.
- D. Section 07 62 00 - Sheet Metal Flashing and Trim: Flashings.
- E. Section 07 92 00 - Joint Sealants: Sealing joints indicated to be left open for sealant.
- F. Products installed, but not furnished, in the Section include:
 - 1. Steel lintels and shelf angles for stone masonry specified in Section 05

1.3 REFERENCE STANDARDS

- A. ASTM C119 - Standard Terminology Relating to Dimension Stone; 2022.
- B. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2019a, with Editorial Revision.
- C. ASTM C568/C568M - Standard Specification for Limestone Dimension Stone; 2022.
- D. ASTM C1515 - Standard Guide for Cleaning of Exterior Dimension Stone, Vertical And Horizontal Surfaces, New or Existing; 2020.
- E. ASTM C1528/C1528M - Standard Guide for Selection of Dimension Stone; 2020.
- F. ASTM C1714/C1714M - Standard Specification for Preblended Dry Mortar Mix for Unit Masonry; 2019a.
- G. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures; 2022, with Errata (2024).

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section.

1.5 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide stone masonry cladding capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Wind Load: As indicated in Structural General Notes paragraph "Design Live Loads."
 - 2. Seismic Loads: As indicated in Structural General Notes paragraph "Design Live Loads."
- B. All anchorage components, miscellaneous metal fabrications and cold formed framing systems indicated on the drawings for support of stone are diagrammatic and are not intended to be complete or to restrict the Prime Contractor to specific anchorage or support systems. The Stone Masonry Contractor shall be solely responsible for the structural performance of all stone work, including but not limited to the following, at no additional cost to the Owner:
 - 1. Stone anchorage systems types for gravity anchors, wind/lateral anchors, and other conditions as indicated or required.

2. The systems utilized for attachment of exterior stone gravity and wind/lateral anchors to existing back-up wall as required to prevent movement or slipping of anchors. The method of attachment and types of anchors, metal fabrications and other materials and accessories shall be designed and selected by the Prime Contractor based on both the specified performance requirements and the limitations of the strength of the existing backup wall materials and wall systems design.
3. Coordination of anchor systems with existing back up structure as required.
- C. Thermal Movements: Provide stone masonry cladding system that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing displacement of stone, opening of joints, overstressing of components, failure of joint sealants and connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- D. Design stone supports and anchors, including cold formed steel backup framing systems, miscellaneous metal support fabrications and connections to building structure, to withstand loads indicated without exceeding allowable stresses established by the following:
 1. For Structural Steel: AISC S335, "Specification for Structural Steel Buildings Allowable Stress Design and Plastic Design with Commentary."
 2. For Cold-Formed Steel: AISI SG-673, Part I, "Specification for the Design of Cold- Formed Steel Structural Members."
 3. For Cold-Formed Stainless Steel: ASCE 8, "Specification for the Design of Cold- Formed Stainless Steel Structural Members."
 4. For Cast-in-Place and Post-Installed Anchors in Concrete: One-fourth of anchor's tested capacity when installed in concrete with compressive strength indicated.
 5. For Post-Installed Anchors in Grouted Concrete Masonry Units: One-sixth of anchor's tested capacity when installed in concrete masonry units indicated.
- E. Limit deflection in each cold formed steel backup framing system assembly caused by indicated loads and thermal movements, acting singly or in combination with one another, to the deflection that the stone can withstand, but not more than the following maximums:
 1. 1/16 inch, measured in plane of wall.
 2. 1/720 of panel's clear span but not more than 1/4 inch, measured perpendicular to wall.
- F. Provisions for Fabrication and Erection Tolerances: Allow for fabrication and erection tolerances and for structural deflections from loads and other causes.
 1. Coordinate with existing backup wall conditions.
 2. Structural-steel fabrication and erection tolerances are specified in Division 5 Section "Structural Steel."
 3. Allow for vertical deflection of L/600 or 3/8" in 20-foot span of structural members supporting stone masonry cladding system due to loads (including live loads) imposed on building's structural frame after stone installation.
- G. Control of Corrosion and Staining: Prevent galvanic and other forms of corrosion as well as staining by isolating metals, air/water barrier, sealants, backer rods and other materials from direct contact with incompatible materials. Use materials that are nonstaining to exposed surfaces of stone and joint materials.

1.6 SUBMITTALS

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

- B. Product Data: Provide data on stone units, _____, mortar, and reinforcement.
- C. Shop Drawings: Show details of fabrication and installation of stone masonry cladding, including dimensions and profiles of stone units; arrangement and details of jointing, supporting, anchoring, and bonding stone masonry cladding; and details showing relationship with, attachment to, and reception of adjacent construction and all related work.
 - 1. Include large scale elevations of all proposed façade stone, indicating actual joint locations and sizes. Where false joints are provided, indicate locations and sizes of false joints on elevations.
 - 2. Include large-scale details of decorative surfaces and inscriptions.
 - 3. Include complete information and details for miscellaneous metal support fabrications including attachment to supporting materials.
 - 4. Include complete information and details for thermally broken relieving angle assemblies including attachment to supporting materials and separation of dissimilar metals.
 - 5. Include complete shop drawings and installation details for air/water barrier.
 - 6. Include complete shop drawings and installation details for flashing and break- formed flashing profiles.
 - 7. Locations, sizes and details for shop-fabricated cuts in limestone for devices mounted to limestone veneer by others.
- D. Samples: Submit two stone samples illustrating _____, color range, texture, and markings.
 - 1. Samples: Submit mortar color samples.
 - 2. Installer's Qualification Statement.
 - 3. NSI Installer Qualification: Documentation of Natural Stone Institute Accreditation.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type required by this section, with minimum 5 years of documented experience.
- B. Engage an experienced installer who has completed stone masonry cladding similar in material, design, and extent to that indicated for Project that has resulted in construction with a record of successful in-service performance.
 - 1. Installer shall assume responsibility for engineering, fabricating, and installing stone masonry cladding system.
 - 2. Engineering Responsibility: Engage a qualified professional engineer to prepare or supervise the preparation of data for stone masonry cladding, miscellaneous metal fabrications, cold formed steel framing backup systems, thermally broken relieving angles assemblies and stone anchorage system including drawings and comprehensive engineering analysis that shows the system's compliance with specified requirements.
 - 3. Engineer shall be licensed in the state of Illinois, and shall provide proof and references from the design of three (3) previous stone support systems
- C. Installer Qualifications: Natural Stone Institute (NSI) Accredited Commercial B Contractor (light commercial); www.naturalstoneinstitute.org/#sle.
- D. Source Limitations for Stone: Obtain stone, regardless of finish, from one quarry with resources to provide materials of consistent quality in appearance and physical properties.

1.8 MOCK-UP

- A. Build mockups to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockup of typical wall area as shown on Drawings.

- a. First mockup consists of stonework integrated into freestanding wall section combined with other materials such as Unit Masonry, Curtain Wall, etc.
 - b. Second mockup consists of in-place installation of stone pieces and accessories indicated in the Drawings.
- B. Protect accepted mockups from the elements with weather-resistant membrane.
- C. Approval of mockups is for color, texture, and blending of stone; relationship of mortar and sealant colors to stone colors; tooling of joints; and aesthetic qualities of workmanship.
 1. Approval of mockups is also for other material and construction qualities Architect specifically approves in writing.
 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.
- D. Protect and maintain mockup as a reference until the conclusion of construction.
- E. Second in-place mockup may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect stone from discoloration during storage on site.
- B. Provide ventilation to prevent condensation from forming on stone.

1.10 FIELD CONDITIONS

- A. Cold Weather Requirements: Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.

PART 2 PRODUCTS

2.1 STONE

- A. Dolomitic Limestone: _____ variety; complying with ASTM C568/C568M Classification III - High Density.
- B. Basis-of-Design Product: Provide "Napoleno Gray" as manufactured by Phenix Marble Company; www.phenixmarble.com/, or comparable product of other manufacturers approved by the Architect.
 1. Color: Grey.
 2. Cut: Vein/Napoleon.
 3. Grain Direction: Vertical.
 4. Cut stone from one block or contiguous, matched blocks in which natural markings occur.
 5. Surface Finish: Honed; complying with ASTM C119 and ASTM C1528/C1528M.
- C. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
- D. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
 1. Provide special shapes of formed L-shaped corners, movement joints, and other special conditions.
 2. Provide shapes as indicated in the contract documents.
 3. Formed L-shade corners required.
 4. Sizes: 16" wide x 48" tall x 4" thick nominal.
 5. Bond pattern: As indicted on drawings.

2.2 MORTAR APPLICATIONS

- A. At Contractor's option, mortar may be field-mixed from packaged dry materials, made from factory premixed dry materials with addition of water only, or ready-mixed.
- B. Mortar Color: Natural gray unless otherwise indicated.
- C. Pointing Mortars: Pointing or grouting mortars used to fill the joints between individual stone veneer units once the setting bed mortar has sufficiently cured.
 - 1. Site-Mixed: ASTM C270, Type N or Type S, using the Proportion Method as specified in Section 04 05 11.
 - 2. Prepackaged/Preblended: ASTM C1714/C1714M, Type N or Type S.
 - 3. Prepackaged/Preblended Latex Modified: ANSI A118.4 or ANSI A118.15.

2.3 MORTAR MIXES

- A. Packaged Dry Material for Mortar for Unit Masonry: Premixed Portland cement, hydrated lime, and sand; complying with ASTM C1714/C1714M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
 - 1. Color: Standard gray.
 - 2. Manufacturers:
 - a. Amerimix, an Oldcastle brand; ____: www.amerimix.com/#sle.
 - b. The QUIKRETE Companies; ____: www.quikrete.com/#sle.
 - c. Solomon Colors; SGS Mortar Colors.
- B. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio.

2.4 ACCESSORIES - ANCHORED VENEER

- A. Provide anchors of type and size required to support stone masonry cladding and to sustain imposed loads. Select stone anchors and anchor fasteners which are suitable for existing back up wall substrate. Coordinate anchor design with existing in-place adjacent stone masonry. Fabricate from the following metals for conditions indicated:
 - 1. Stainless Steel: ASTM A 666, Type 304, temper as required to support loads imposed without exceeding allowable design stresses.
 - a. Fasteners for Stainless-Steel Anchors: Annealed stainless-steel bolts, nuts, and washers of same alloy as anchors. ASTM F 593 for bolts and ASTM F 594 for nuts.
- B. Post-Installed Anchors in Backup Construction: Anchors of type indicated below, fabricated from corrosion-resistant materials, with capability to sustain, without failure, load imposed within factors of safety indicated for connections, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency. Coordinate anchor type with backup wall construction.
 - 1. Cast-in-place anchors.
 - 2. Chemical anchors.
 - 3. Expansion anchors.
 - 4. Undercut anchors.
- C. Flashings: See Section 04 20 00.
- D. Weep/Cavity Vents: ____ See Section 04 20 00.
- E. Back Coating:
 - 1. Bituminous. Apply to the backside and non-exposed surfaces of stone at grades.
- F. Cleaning Solution: Type that will not harm stone, joint materials, or adjacent surfaces.

2.5 STONE FABRICATION - ANCHORED VENEER

- A. Nominal Thickness: 4 inch.
- B. Nominal Face Size: 16 by 48 inch.
- C. Pattern and Coursing: As indicated in contract documents.
- D. Fabricate for 3/8 inch beds and joints.
- E. Bed and Joint Surfaces:
 - 1. Cut or sawn full square for full thickness of unit.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that support work and site conditions are ready to receive work of this section.

3.2 PREPARATION - ANCHORED VENEER

- A. Establish lines, levels, and coursing. Protect from disturbance.
- B. Clean stone prior to installation. Do not use wire brushes or implements that mark or damage exposed surfaces.
- C. Clean sawn surfaces of rust stains and iron particles.
- D. Coat back surfaces not to be in contact with setting mortar with back coating material. Allow coating to cure.
 - 1. Apply bituminous dampproofing to beds, joints, back surfaces, and face surfaces up to rough grade.

3.3 INSTALLATION - ANCHORED VENEER

- A. Install flashings of longest practical length and seal watertight to back-up. Lap end joints minimum 6 inches and seal watertight.
- B. Size stone units to fit opening dimensions and perimeter conditions.
- C. Arrange stone pattern to provide color uniformity and minimize visual variations, and provide a uniform blend of stone unit sizes.
- D. Arrange stone coursing in running bond vertically with consistent joint width.
- E. Set stone in full mortar setting bed to fully support stone over bearing surface. Use setting buttons or shims to maintain correct joint width.
- F. Install weep/cavity vents in vertical stone joints at 32 inches on center horizontally; immediately above horizontal flashings, above shelf angles and supports, and at top of each cavity space; do not permit mortar accumulation in cavity space.

3.4 REINFORCEMENT AND ANCHORAGE - ANCHORED VENEER

- A. Anchor stone masonry to backup with anchors complying with performance criteria defined in this Section. Secure anchors to backup wall in compliance with performance criteria.
- B. Space anchors as required by performance requirements of this Section.
- C. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with mortar.
- D. Set stone in full bed of mortar with full head joints unless otherwise indicated. Build anchors into mortar joints as stone is set.
- E. Provide minimum 1-inch cavity between stone masonry and backup construction unless otherwise indicated. Keep cavity free of mortar droppings and debris.
 - 1. Place mortar spots in cavity at veneer anchors to maintain spacing.
 - 2. Slope beds toward cavity to minimize mortar protrusions into cavity.

- 3. Do not attempt to trowel or remove mortar fins protruding into cavity.
- F. Rake out joints for pointing with mortar to depth of not less than 1/2 inch before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

3.5 INSTALLATION - 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.
- B. See Section 04 20 00 for flashing requirements.

3.6 CONTROL AND EXPANSION JOINTS

- A. Form joints as detailed on drawings.

3.7 TOLERANCES

- A. Install masonry within the site tolerances found in TMS 402/602.
- B. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
- C. Maximum Variation from Plane of Wall: 1/4 inch in 10 feet and 1/2 inch in 20 feet or more.
- D. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
- E. Maximum Variation from Level Coursing: 1/8 inch in 3 feet and 1/4 inch in 10 feet; 1/2 inch in 30 feet.
- F. Maximum Variation of Joint Thickness: 1/8 inch in 3 feet.

3.8 CLEANING

- A. Remove excess mortar as work progresses, and upon completion of work.
- B. Replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces with cleaning solution.
- D. Clean exterior stone per ASTM C1515.
- E. Use non-metallic tools in cleaning operations.

3.9 PROTECTION

- A. During temporary storage on site, at the end of working day, and during rainy weather, cover stone work exposed to weather with non-staining waterproof coverings, securely anchored.

END OF SECTION 04 43 13

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Structural steel framing members.
- B. Structural steel support members and struts.
- C. Base plates, shear stud connectors and expansion joint plates.
- D. Grouting under base plates.

1.2 RELATED REQUIREMENTS

- A. Section 05 21 00 - Steel Joist Framing.
- B. Section 05 31 00 - Steel Decking: Support framing for small openings in deck.
- C. Section 05 50 00 - Metal Fabrications: Steel fabrications affecting structural steel work.
- D. Section 09 90 00 "Paints, Stains, and Coatings" for painting requirements.
- E. **Not all steel is shown on the structural sheets. See Architectural drawings for additional steel that is to be used as trim and signage. All steel, even steel that is shown on the architectural drawings, shall be provided by the structural steel subcontractor.**

1.3 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.
- B. Heavy Sections: Rolled and built-up sections as follows:
 - 1. Shapes included in ASTM A6/A6M with flanges thicker than 1-1/2 inches.
 - 2. Welded built-up members with plates thicker than 2 inches.
- C. Demand-Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the seismic-load-resisting system and which are indicated as "demand critical" or "seismic critical" on Drawings.

1.4 REFERENCE STANDARDS

- A. AISC (MAN) - Steel Construction Manual; 2023.
- B. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges; 2022.
- C. AISC 360 - Specification for Structural Steel Buildings; 2022.
- D. ASTM A6/A6M - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling; 2023.
- E. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- G. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished; 2018.
- H. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- I. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.
- J. ASTM A563/A563M - Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric); 2021a.
- K. ASTM A992/A992M - Standard Specification for Structural Steel Shapes; 2022.

- L. ASTM C827/C827M - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures; 2023.
- M. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
- N. ASTM E164 - Standard Practice for Contact Ultrasonic Testing of Weldments; 2019.
- O. ASTM F436/F436M - Standard Specification for Hardened Steel Washers Inch and Metric Dimensions; 2019.
- P. ASTM F959/F959M - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series; 2017a.
- Q. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength; 2020.
- R. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength; 2023.
- S. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021.
- T. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
- U. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel AC172; 2019.
- V. RCSC (HSBOLT) - Specification for Structural Joints Using High-Strength Bolts; Research Council on Structural Connections; 2020.
- W. SSPC-SP 2 - Hand Tool Cleaning; 2018.
- X. SSPC-SP 3 - Power Tool Cleaning; 2018.
- Y. SSPC-SP 16 - Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals; 2020.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data:
 - 1. Structural-steel materials.
 - 2. High-strength, bolt-nut-washer assemblies.
 - 3. Shear stud connectors.
 - 4. Anchor rods.
 - 5. Threaded rods.
 - 6. Forged-steel hardware.
 - 7. Shop primer.
 - 8. Galvanized-steel primer.
 - 9. Etching cleaner.
 - 10. Galvanized repair paint.
 - 11. Shrinkage-resistant grout.
- C. Shop Drawings:
 - 1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
 - 2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 3. Include embedment Drawings.
 - 4. 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.

5. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
6. Indicate locations and dimensions of protected zones.
7. Identify demand-critical welds.
8. Identify members not to be shop primed.
- D. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
 1. Welding certificates
- E. Erector's Qualification Statement.
- 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 materials, including chemical and physical properties.
- H. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Fabricate structural steel members in accordance with AISC (MAN) "Steel Construction Manual."
- B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and no more than 12 months before start of scheduled welding work.
 1. Welders and welding operators performing work on bottom-flange, demand-critical welds are to pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G are to be considered separate processes for welding personnel qualification.
- C. Fabricator Qualifications: A qualified steel fabricator that is accredited by the International Accreditation Service (IAS) Fabricator Inspection Program for Structural Steel in accordance with IAS AC172.
- D. Erector Qualifications: A qualified Erector who participates in the AISC Quality Certification Program and is designated an AISC (MAN)-Certified Erector, Category ACSE.

1.7 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 re-lubricate bolts and nuts that become dry or rusty before use.
 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with applicable provisions of the following specifications and documents:
 1. ANSI/AISC 303.
 2. ANSI/AISC 360.

3. RCSC (HSBOLT)'s "Specification for Structural Joints Using High-Strength Bolts."
- B. Connection Design Information:
 1. Option 1: Connection designs have been completed and connections indicated on the Drawings.
 2. Moment Connections: Type FR, fully restrained.
 3. Construction: Combined system of moment frame and braced frame .

2.2 STRUCTURAL-STEEL MATERIALS

- A. Steel Angles and Plates: ASTM A36/A36M.
- B. Steel W Shapes and Tees: ASTM A992/A992M.
- C. Channels, Angles, M-Shapes: ASTM A36/A36M.
- D. Plate and Bar: ASTM A36/A36M.
- E. Cold-Formed Structural Tubing: ASTM A500/A500M, Grade B.
- F. Pipe: ASTM A53/A53M, Type E or Type S, Grade B, Finish Black, except where indicated to be galvanized.
- G. Shear Stud Connectors: Made from ASTM A108 Grade 1015 bars.
- H. High-Strength Structural Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, with matching compatible ASTM A563/A563M nuts and ASTM F436/F436M washers.
- I. Headed Anchor Rods: ASTM F1554 Grade 36, plain.
- J. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- K. Grout: ASTM C1107/C1107M; Non-shrink; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
 1. Minimum Compressive Strength at 28 Days: 7,000 pounds per square inch.
 2. Height Change, Plastic State; when tested according to ASTM C827/C827M:
 - a. Maximum: Plus 4 percent.
- L. Shop and Touch-Up Primer: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.
- M. Touch-Up Primer for Galvanized Surfaces: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

2.3 BOLTS AND CONNECTORS

- A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563/A563M, Grade DH, 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/F959M, Type 325-1, compressible-washer type with plain finish.
- B. High-Strength A490 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A490, Type 1, heavy-hex steel structural bolts or Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends; ASTM A563, Grade DH, 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/F959M, Type 490-1, compressible-washer type with plain finish.
- C. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
 1. Finish: Hot-dip zinc coating.

2. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with mechanically deposited zinc coating finish.
- D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, heavy-hex head assemblies, consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
 1. Finish: Plain.
- E. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

- A. Headed Anchor Rods: ASTM F1554, Grade 36, straight.
 1. Nuts: ASTM A563/A563M heavy-hex carbon steel.
 2. Plate Washers: ASTM A36/A36M carbon steel.
 3. Washers: ASTM F436, Type 1, hardened carbon steel.
 4. Finish: Plain.
- B. Threaded Rods: ASTM A36/A36M.
 1. Nuts: ASTM A63 heavy-hex carbon steel.
 2. Washers: ASTM F436, Type 1, hardened carbon steel.
 3. Finish: Plain.

2.5 FORGED-STEEL STRUCTURAL HARDWARE

- A. Clevises and Turnbuckles: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1035.
- B. Eye Bolts and Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1030.
- C. Sleeve Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1018.

2.6 PRIMER

- A. Steel Primer:
 1. SSPC-Paint 23, latex primer.
 2. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- B. Galvanized-Steel Primer: MPI#26.
 1. Etching Cleaner: MPI#25, for galvanized steel.
 2. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.7 SHRINKAGE-RESISTANT GROUT

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

2.8 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.
 1. Camber structural-steel members where indicated.
 2. Fabricate beams with rolling camber up.
- B. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.

1. Mark and match-mark materials for field assembly.
2. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- C. Shop fabricate to greatest extent possible.
- D. 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.
- E. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- F. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- G. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with SSPC-SP 2.
- H. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.
- I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel 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, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.
- J. Continuously seal joined members by continuous welds. Grind exposed welds smooth.

2.9 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength 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. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

2.10 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with AASTM A123/A123M.
 1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
 2. Galvanize lintels attached to structural-steel frame and located in exterior walls.
 3. Galvanize columns, beams, connections, and miscellaneous steel exposed to exterior.

2.11 SHOP PRIMING

- A. Shop prime steel surfaces, except the following:
 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 2. Surfaces to be field welded.
 3. Surfaces of high-strength bolted, slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 5. Galvanized surfaces unless indicated to be painted.

- B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:
 - 1. SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner or in accordance with SSPC-SP 16.
- D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2. 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.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify, with certified 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 existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.
- B. Baseplates, Bearing Plates, 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.
- C. Weld plate washers to top of baseplate.
 - 1. 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.
 - 2. Promptly pack shrinkage-resistant 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 grouting.
- D. Maintain erection tolerances of structural steel within ANSI/AISC 303.

- E. 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 are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- F. Splice members only where indicated.
- G. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
- H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type 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 ANSI/AISC 303 and ANSI/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.
- C. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.
- D. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

3.5 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

- A. Install prefabricated building columns to comply with ANSI/AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

3.6 REPAIR

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting:
 - 1. 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.
 - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- C. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

3.7 TOLERANCES

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

3.8 FIELD QUALITY CONTROL

- A. An independent testing agency will perform the following field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
 - 1. Verify structural-steel materials and inspect steel frame joint details.
 - 2. Verify weld materials and inspect welds.
 - 3. Verify connection materials and inspect high-strength bolted connections.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
 - 1. Bolted Connections: Inspect bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
 - 2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.
 - a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - 1) Liquid Penetrant Inspection: ASTM E165/E165M.
 - 2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - 3) Ultrasonic Inspection: ASTM E164.
 - 4) Radiographic Inspection: ASTM E94/E94M.
 - 3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 - b. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

END OF SECTION 05 12 00

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**SECTION 05 21 00
STEEL JOIST FRAMING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Open web steel joists, with bridging, attached seats and anchors.

1.2 RELATED REQUIREMENTS

- A. Section 05 12 00 - Structural Steel Framing: Grouting base plates and bearing plates. Superstructure framing.
- B. Section 05 31 00 - Steel Decking: Bearing plates and angles.
- C. Section 05 31 00 - Steel Decking: Support framing for openings less than 18 inches in decking.
- D. Section 05 50 00 - Metal Fabrications: Non-framing steel fabrications attached to joists.

1.3 REFERENCE STANDARDS

- A. ASTM E94/E94M - Standard Guide for Radiographic Examination Using Industrial Radiographic Film; 2017.
- B. ASTM E165/E165M - Standard Practice for Liquid Penetrant Testing for General Industry; 2023.
- C. ASTM E709 - Standard Guide for Magnetic Particle Testing; 2021.
- D. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
- E. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel AC172; 2019.
- F. RCSC (HSBOLT) - Specification for Structural Joints Using High-Strength Bolts; Research Council on Structural Connections; 2020.
- G. SJI 100 - Standard Specifications for K-Series, LH-Series, and DLH-Series Open Web Steel Joists, and for Joist Girders; 2020.
- H. SJI Technical Digest No. 9 - Handling and Erection of Steel Joists and Joist Girders; 2008.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate standard designations, joist coding, configurations, sizes, spacings, cambers, locations of joists, joist leg extensions, bridging, connections, and attachments.

1.5 QUALITY ASSURANCE

- A. Design connections not detailed on drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.
- B. Perform Work, including that for headers and other supplementary framing, in accordance with SJI 100 Standard Specifications Load Tables and SJI Technical Digest No. 9.
- C. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and dated no more than 12 months before start of scheduled welding work.
- D. Fabricator Qualifications: A qualified steel fabricator that is accredited by the International Accreditation Service (IAS) Fabricator Inspection Program for Structural Steel in accordance with IAS AC172.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Transport, handle, store, and protect products to SJI requirements.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

2.2 PRIMERS

- A. Primer:
1. SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.
 2. Primer: Provide shop primer that complies with Section 09 90 00 "Paint, Stains, & Coat-ings."

2.3 STEEL JOIST ACCESSORIES

- A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
- B. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch 13 mm of finished wall surface unless otherwise indicated.
1. Finish: Plain, uncoated Hot-dip zinc coating, ASTM A 153/A 153M, Class C Mechanically deposited zinc coating, ASTM B 695, Class 50.
- C. High-Strength Bolts, Nuts, and Washers: ASTM A 325 ASTM A 325M, Type 1, heavy hex steel structural bolts; ASTM A 563 ASTM A 563M heavy hex carbon-steel nuts; and ASTM F 436 ASTM F 436M hardened carbon-steel washers.
1. Finish: Plain Hot-dip zinc coating, ASTM A 153/A 153M, Class C Mechanically deposited zinc coating, ASTM B 695, Class 50.
- D. Welding Electrodes: Comply with AWS standards.
- E. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20 ASTM A 780/A 780M.
- F. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.4 CLEANING AND SHOP PAINTING

- A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.
- B. Do not prime paint joists and accessories to receive sprayed fire-resistive materials.
- C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil thick.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions prior to beginning work.

3.2 ERECTION

- A. Erect joists with correct bearing on supports.
- B. Allow for erection loads. Provide sufficient temporary bracing to maintain framing safe, plumb, and in true alignment.

- C. After joist alignment and installation of framing, field weld joist seats to steel bearing surfaces.
- D. Do not permit erection of decking until joists are braced, bridged, and secured or until completion of erection and installation of permanent bridging and bracing.
- E. Do not field cut or alter structural members without approval of joist manufacturer.
- F. After erection, prime welds, damaged shop primer, damaged galvanizing, and surfaces not shop primed , except surfaces specified not to be primed.

3.3 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From True Alignment: 1/4 inch.

3.4 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
- B. High-Strength Bolts: Provide testing and verification of field-bolted connections in accordance with RCSC (HSBOLT) "Specification for Structural Joints Using High-Strength Bolts", testing at least ____ percent of bolts at each connection.
- C. Welded Connections: Visually inspect all field-welded connections and test at least ____ percent of welds using one of the following:
 - 1. Radiographic testing performed in accordance with ASTM E94/E94M.
 - 2. Ultrasonic testing performed in accordance with ASTM E164.
 - 3. Liquid penetrant inspection performed in accordance with ASTM E165/E165M.
 - 4. Magnetic particle inspection performed in accordance with ASTM E709.

END OF SECTION 05 21 00

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SECTION 05 31 00
STEEL DECKING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Acoustical roof deck.
- B. Roof deck.
- C. Composite floor deck.
- D. Supplementary framing for openings up to and including 18 inches.
- E. Acoustical insulation in roof deck flutes and end dams.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete topping over metal deck.
- B. Section 05 12 00 - Structural Steel Framing: For shop- and field-welded shear connectors.
- C. Section 05 50 00 - Metal Fabrications: For framing deck openings with miscellaneous steel shapes.

1.3 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; 2023, with Editorial Revision.
- B. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021.
- C. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
- D. AWS D1.3/D1.3M - Structural Welding Code - Sheet Steel; 2018, with Errata (2022).
- E. SDI (DM) - Publication No.30, Design Manual for Composite Decks, Form Decks, and Roof Decks; 2007.
- F. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
- B. Product Data: Provide deck profile characteristics, dimensions, structural properties, and finishes.
- C. Shop Drawings: Indicate deck plan, support locations, projections, openings, reinforcement, pertinent details, and accessories.
- D. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
 - 1. Welding certificates.
- E. Product Certificates: For each type of steel deck.
- F. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
 - 1. Power-actuated mechanical fasteners.
- G. Evaluation Reports: For steel deck, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Design deck layout, spans, fastening, and joints under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.
- B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.3/D1.3M and dated no more than 12 months before start of scheduled welding work.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Cut plastic wrap to encourage ventilation.
- B. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- C. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
 - 1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

2.2 MANUFACTURERS

- A. Steel Deck: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Canam Steel Corporation: www.canam-steeljoists.ws.
 - 2. New Millennium Building Systems: www.newmill.com/#sle.
 - 3. Nucor-Vulcraft Group: www.vulcraft.com/#sle.

2.3 STEEL DECK

- A. All Deck Types: Select and design metal deck in accordance with SDI Design Manual.
 - 1. Calculate to structural working stress design and structural properties specified.
- B. Acoustical Roof Deck: Non-composite type, steel sheet with plain vertical flute faces perforated with 1/8 inch diameter holes staggered 3/8 inch on center:
 - 1. Ungalvanized Steel Sheet: ASTM A1008/A1008M, Designation SS, Grade 33, Type 1.
 - 2. Primer: Shop coat of manufacturer's standard primer paint over cleaned and phosphatized substrate.
 - 3. Minimum Base Metal Thickness: 22 gauge, 0.0299 inch.
 - 4. Nominal Height: 1-1/2 inch.
 - 5. Profile: Fluted; SDI NR.
 - 6. Side Joints: Lapped, welded.
 - 7. End Joints: Lapped, welded.
- C. Roof Deck: Non-composite type, fluted steel sheet:
 - 1. Ungalvanized Steel Sheet: ASTM A1008/A1008M, Designation SS, Grade 33, Type 1.
 - 2. Primer: Shop coat of manufacturer's standard primer paint over cleaned and phosphatized substrate.
 - 3. Deck Profile: As indicated.
 - 4. Profile Depth: As indicated.
 - 5. Design Uncoated-Steel Thickness: As indicated.
 - 6. Span Condition: Triple span or more.
 - 7. Side Laps: Overlapped.
- D. Composite Floor Deck: Fluted steel sheet embossed to interlock with concrete:
 - 1. Ungalvanized Steel Sheet: ASTM A1008/A1008M, Designation SS, Grade 33, Type 1.

2. Primer: Shop coat of manufacturer's standard primer paint over cleaned and phosphatized substrate.
3. Deck Profile: As indicated.
4. Profile Depth: As indicated.
5. Design Uncoated-Steel Thickness: As indicated.
6. Span Condition: Triple span or more.
7. Side Laps: Overlapped.

2.4 ACCESSORY MATERIALS

- A. Welding Materials: AWS D1.1/D1.1M.
- B. Acoustical Insulation: Glass fiber type, minimum 1.1 lb/cu ft density; profiled to suit deck.
- C. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- D. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- E. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- F. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- G. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- H. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.
- I. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.
- J. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
- K. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.
- L. Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight.
- M. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Erect metal deck in accordance with SDI Design Manual and manufacturer's instructions. Align and level.
- B. At welded male/female side laps weld at 18 inches on center maximum.
- C. Install temporary shoring before placing deck panels if required to meet deflection limitations.
- D. Locate deck bundles to prevent overloading of supporting members.

- E. 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.
- F. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- G. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- H. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- I. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- J. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

- A. Fasten roof-deck panels to steel supporting members as indicated :
 - 1. Weld or Fastener Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds or fasteners as indicated.
 - 2. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 18 inches , and as follows:
 - 1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
 - 1. End Joints: Lapped 2 inches minimum.
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld flanges to top of deck. Space welds not more than 12 inches apart with at least one weld at each corner.
 - 1. Install reinforcing channels or zees in ribs to span between supports and weld or mechanically fasten.
- E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
 - 1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.
- F. 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.
- G. Sound-Absorbing Insulation: Installation into topside ribs of deck.

3.4 FLOOR-DECK INSTALLATION

- A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
 - 1. Weld Diameter: 5/8 inch , nominal.
 - 2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart.
 - 3. Weld Spacing: Space and locate welds as indicated.
 - 4. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 36 inches, and as follows:

1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
2. Mechanically clinch or button punch.
3. Fasten with a minimum of 1-1/2-inch- long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches , with end joints as follows:
 1. End Joints: Lapped.
- D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.
- E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.
- F. Install piercing hanger tabs at 14 inches apart in both directions, within 9 inches of walls at ends, and not more than 12 inches from walls at sides unless otherwise indicated.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Field welds will be subject to inspection.
- C. Prepare test and inspection reports.

3.6 PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780/A 780M 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.
 2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- C. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

END OF SECTION 05 31 00

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SECTION 05 40 00
COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Formed steel stud exterior wall and interior wall framing.
- B. Formed steel joist and purlin framing and bridging.
- C. Ceiling joist framing
- D. Soffit Framing

1.2 RELATED REQUIREMENTS

- A. Section 04 26 13 - Masonry Veneer: Veneer masonry supported by wall stud metal framing.
- B. Section 09 22 16 - Non-Structural Metal Framing: for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.3 DEFINITIONS

- A. General: See AISI S240 for definitions of terms used in this section.
- B. Connection: A combination of structural elements and joints used to transmit forces between two or more members.
- C. Connector: A device used to transmit forces between cold-formed steel structural members or between a cold-formed steel structural member and another structural element.

1.4 REFERENCE STANDARDS

- A. ACI CODE-318 - Building Code Requirements for Structural Concrete and Commentary; 2019 (Reapproved 2022).
- B. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members; 2016, with Supplement (2020).
- C. AISI S201 - North American Standard for Cold-Formed Steel Framing - Product Data; 2017.
- D. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing; 2015, with Errata (2020).
- 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 A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- G. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- H. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- I. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- J. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.
- K. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2015.
- L. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2020.
- M. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.
- N. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2023.

- O. ASTM E488/E488M - Standard Test Methods for Strength of Anchors in Concrete Elements; 2022.
- P. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength; 2020.
- Q. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021.
- R. AWS D1.3/D1.3M - Structural Welding Code - Sheet Steel; 2018, with Errata (2022).
- S. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- T. ICC-ES AC708 - Acceptance Criteria for Power-Actuated Fasteners Driven into Concrete, Steel and Masonry Elements; 2019, with Editorial Revision (2021).

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with work of other sections that is to be installed in or adjacent to metal framing systems, including but not limited to structural anchors, cladding anchors, utilities, insulation, and firestopping.
- B. Preinstallation Meeting: Conduct a preinstallation meeting 10 days prior to the start of the work of this section; require attendance by affected installers.

1.6 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on cold-formed steel structural members; include material descriptions and base steel thickness.
 - 1. Cold-formed steel framing materials.
 - 2. Vertical deflection clips.
 - 3. Single deflection track.
 - 4. Double deflection track.
 - 5. Post-installed anchors.
 - 6. Power-actuated anchors.
- 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. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
 - 2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
- D. Design Data:
 - 1. Shop drawings signed and sealed by a professional structural engineer.
 - 2. Design calculations sufficient to demonstrate compliance with design criteria; signed and sealed by a professional structural engineer.
 - 3. Details and calculations for factory-made connectors, signed and sealed by a professional structural engineer.
- E. Inspection Reports: Provide material verification Inspection Reports in accordance with requirements of AISI S240.
- F. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before the start of scheduled welding work.
 - 1. Welding certificates.
- G. Product Test Reports: For each listed product, for tests performed by a qualified testing agency.
 - 1. Steel sheet.
 - 2. Expansion anchors.

3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

1.7 QUALITY ASSURANCE

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Designer Qualifications: Design framing system under direct supervision of a professional structural engineer experienced in designing this work and licensed in the State in which the Project is located.
- C. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
- D. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- E. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."
- F. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.3/D1.3M and dated no more than 12 months before start of scheduled welding work.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. A. Protect and store cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling as required in AISI S202.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Structural Framing:
 1. ClarkDietrich: www.clarkdietrich.com/#sle.
 2. MarinoWARE: www.marinoware.com/#sle.
 3. The Steel Network, Inc: www.SteelNetwork.com/#sle.
- B. Connectors:
 1. ClarkDietrich: www.clarkdietrich.com/#sle.
 2. MarinoWARE: www.marinoware.com/#sle.
 3. Simpson Strong-Tie: www.strongtie.com/#sle.

2.2 PERFORMANCE REQUIREMENTS

- A. Design Requirements: Design cold-formed framing systems, components and connectors to withstand specified design loads in compliance with ICC (IBC), ASCE 7, AISI S100, and AISI S240.
- B. Regulatory Requirements: Comply with applicable building code criteria for loads, including seismic loads.
- C. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 1. Interior Load-Bearing Wall Framing: Horizontal deflection of 1/360 of the wall height under a horizontal load of 5 lbf/sq. ft..

2. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/360 at typical finishes and 1/600 at masonry veneer.
 3. Interior Non-Load-Bearing Framing: Horizontal deflection of 1/360 of the wall height under a horizontal load of 5 lbf/sq. ft..
 4. Ceiling Joist Framing: Vertical deflection of 1/360 of the span for live loads and 1/240 for total loads of the span.
- D. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
- E. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
1. Upward and downward movement of 1 inch.
- F. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
- G. Cold-Formed Steel Framing Design Standards:
1. Floor and Roof Systems: AISI S210.
 2. Wall Studs: AISI S211.
 3. Headers: AISI S212.
 4. Lateral Design: AISI S213.
- H. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.
- I. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.3 MATERIALS

- A. Material and Product Requirements Criteria: AISI S201.
- B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S240.
1. Structural Grade: ST33H.
 2. Corrosion Protection Coating Designation: CP 60 (G60, A60, or AZ50) in accordance with AISI S240.
- C. Steel Sheet for Vertical Deflection Clips: ASTM A653/A653M, subject to the ductility limitations indicated in AISI S240.
1. Structural Grade: 33.
 2. Corrosion Protection Coating Designation: CP 60 (G60, A60, or AZ50) in accordance with AISI S240.

2.4 STRUCTURAL FRAMING COMPONENTS

- A. Wall Studs and Track Sections: AISI S240; c-shaped studs and u-shaped track sections in stud-matching nominal width and compatible height.
- B. Jamb Studs: AISI S240; manufactured, engineered, c-shaped with wide flanges, designed to replace conventional double-stud framing at openings.
1. Thickness: 43 mils, 0.0428 inch, minimum.
 2. Depth: 1-5/8 inches.

- C. Headers: AISI S240; manufactured, engineered two-member assemblies, with wide flanges, designed to replace conventional box or nested header framing at openings.
 - 1. Thickness and Depth: As indicated on drawings.
 - 2. Jamb Mounting Clips: Manufacturer's standard.

2.5 CONNECTIONS

- A. Performance Requirements: Provide connections in compliance with requirements of AISI S240.
- B. Fixed Connections: Provide nonmovement devices for tie-down to foundation, floor-to-floor tie-down, roof-to-wall tie-down, joist hangers, gusset plates, and stiffeners.
- C. Bridging Connections: Provide mechanical load-transferring devices that accommodate wind load torsion and weak axis buckling induced by axial compression loads. Provide bridging connectors where indicated on the drawings.
- D. Vertical Deflection Clips, Exterior: Manufacturer's standard clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.6 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.
- B. Anchor Bolts: ASTM F1554 Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153/A153M, Class C.
- C. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI CODE-318 greater than or equal to the design load, as determined by testing per ASTM E488/E488M conducted by a qualified testing agency.
- D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.
- F. Welding Electrodes: Comply with AWS standards.

2.7 ACCESSORIES

- A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
 - 1. Supplementary framing.
 - 2. Bracing, bridging, and solid blocking.
 - 3. Web stiffeners.
 - 4. Anchor clips.
 - 5. End clips.
 - 6. Foundation clips.
 - 7. Stud kickers and knee braces.
 - 8. Joist hangers and end closures.
 - 9. Hole reinforcing plates.

- 10. Backer plates.
- C. Galvanizing Repair: Touch up bare steel with zinc-rich paint in compliance with ASTM A780/A780M.
- D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.
- E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.8 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
 - 1. Fabricate framing assemblies using jigs or templates.
- B. Cut framing members by sawing or shearing; do not torch cut.
 - 1. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
- C. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- D. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.
- E. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. Verify field measurements and adjust installation as required.

3.2 PREPARATION

- A. Structural Wall Foundations: For gaps between wall bottom track and top of foundation 1/4 inch or greater, level substrate with loadbearing shims or grout between track and foundation.

3.3 INSTALLATION - GENERAL

- A. Install structural members and connections in compliance with ASTM C1007.
- B. Install sill sealer gasket at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.4 INSTALLATION OF STUDS

- A. Install wall studs plumb and level.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
- D. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- E. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
- F. Cut framing members by sawing or shearing; do not torch cut.
 - 1. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.
- G. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- H. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- I. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- J. Install insulation in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- K. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.
- L. Construct corners using minimum of three studs. Install double studs at wall openings, door and window jambs.
- M. Install studs full length in one piece. Splicing of studs is not permitted.
- N. Provide deflection allowance in stud track, directly below horizontal building framing at non-loadbearing framing.
- O. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.

3.5 INSTALLATION OF JOISTS AND PURLINS

- A. Make provisions for erection stresses. Provide temporary alignment and bracing.

3.6 REPAIR

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

3.7 FIELD QUALITY CONTROL

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

- B. Provide material verification inspections in accordance with requirements of AISI S240.
- C. Provide inspections for welding, mechanical fastening, and cold-formed steel light-frame construction in accordance with requirements of AISI S240.
- D. Testing agency will report test results promptly and in writing to Contractor and Architect.
- E. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.
- F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 TOLERANCES

- A. Studs - Vertical Alignment (Plumbness): 1/960 of span or 1/8 inch in 10 ft, in accordance with ASTM C1007.
- B. Studs - Maximum Variation from True Position: 1/8 inch in accordance with ASTM C1007.
- C. Stud Spacing: 1/8 inch from the designated spacing, provided that the cumulative error does not exceed the requirements of the finishing materials in accordance with ASTM C1007.

3.9 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00

SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Shop fabricated steel and aluminum items.
- B. Steel framing and supports for overhead doors.
- C. Steel tube reinforcement for low partitions.
- D. Steel framing and supports for mechanical and electrical equipment.
- E. Steel framing and supports for applications where framing and supports are not specified in other Sections.
- F. Metal ladders.
- G. Miscellaneous steel trim.
- H. Products furnished, but not installed, under this Section include the following:
 - 1. Loose steel lintels.
 - 2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
 - 3. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Placement of metal fabrications in concrete.
- B. Section 04 20 00 - Unit Masonry: Placement of metal fabrications in masonry.
- C. Section 04 26 13 - Masonry Veneer: Placement of metal fabrications in masonry.
- D. Section 05 12 00 - Structural Steel Framing: Structural steel column anchor bolts.
- E. Section 05 21 00 - Steel Joist Framing: Structural joist bearing plates, including anchorage.
- F. Section 05 73 00 - Decorative Metal Railings.

1.3 REFERENCE STANDARDS

- A. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).
- B. ASME B18.21.1 - Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series); 2009 (Reaffirmed 2016).
- C. ASTM A27/A27M - Standard Specification for Steel Castings, Carbon, for General Application; 2020.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- G. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- H. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- I. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.

- J. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.
- K. ASTM A563/A563M - Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric); 2021a.
- L. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- M. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.
- N. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- O. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- P. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.
- Q. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
- R. ASTM E488/E488M - Standard Test Methods for Strength of Anchors in Concrete Elements; 2022.
- S. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs; 2022.
- T. ASTM F594 - Standard Specification for Stainless Steel Nuts; 2022.
- U. ASTM F1941/F1941M - Standard Specification for Electrodeposited Coatings on Mechanical Fasteners, Inch and Metric; 2016.
- V. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
- W. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
- X. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; 2014, with Errata (2020).
- Y. MFMA-4 - Metal Framing Standards Publication; 2004.
- Z. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; Current Edition.
- AA. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.
- BB. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.

1.4 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
 - 2. Design data: Submit drawings and supporting calculations, signed and sealed by a qualified professional structural engineer.

1.6 QUALITY ASSURANCE

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

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

1.7 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.

2.2 MATERIALS - STEEL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Sections: ASTM A36/A36M.
- C. Steel Tubing: ASTM A500/A500M Grade B cold-formed structural tubing.
- D. Pipe: ASTM A53/A53M, Grade B Schedule 40, black and hot-dip galvanized finish, as 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.
 - 2. Material: ASTM A653/A653M, Grade 33, with standard coating.
- F. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- G. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.3 MATERIALS - ALUMINUM

- A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.
- B. Sheet Aluminum: ASTM B209/B209M, 5052 alloy, H32 or H22 temper.

2.4 FASTENERS

- A. A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless steel fasteners for fastening stainless steel.
 - 2. Provide stainless steel fasteners for fastening aluminum.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563/A563M; and, where indicated, flat washers.
- C. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F593; with hex nuts, ASTM F594; and, where indicated, flat washers; Alloy Group 1.
- D. Eyebolts: ASTM A 489.
- E. Machine Screws: ASME B18.6.3.
- F. Lag Screws: ASME B18.2.1.

- G. Wood Screws: Flat head, ASME B18.6.1.
- H. Plain Washers: Round, ASME B18.22.1.
- I. Lock Washers: Helical, spring type, ASME B18.21.1.
- J. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563/A563M; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- K. Anchors, General: 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 in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.
- L. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.
- 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 B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.
- N. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.5 2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- C. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI (APL)#79 and compatible with topcoat.
 - 1. Use primer that contains pigments that make it easily distinguishable from zinc-rich primer.
- D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- G. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi.

2.6 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Fabricate items with joints tightly fitted and secured.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- G. Furnish components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
 - 1. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- H. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- I. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- J. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- K. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- L. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.7 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.

2.8 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.
 - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize and prime exterior miscellaneous steel trim.

2.9 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.
- B. Galvanize plates.
- C. Prime plates with zinc-rich primer.

2.10 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Galvanize loose steel lintels located in exterior walls.
- C. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.11 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.

2.12 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.
- C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.13 2.13 METAL LADDERS

- A. General:
 - 1. Comply with ANSI A14.3.
 - 2. For elevator pit ladders, comply with ASME A17.1/CSA B44.
- B. Steel Ladders:
 - 1. Space siderails 18 inches (457 mm) apart unless otherwise indicated.
- C. 2. Siderails: Continuous, 3/8-by-2-1/2-inch (9.5-by-64-mm) steel flat bars, with eased edges.
 - 1. Rungs: 1-inch- (25-mm-) diameter steel bars.
 - 2. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
 - 3. Provide nonslip surfaces on top of each rung.
 - 4. Galvanize exterior ladders, including brackets.
 - 5. Prime ladders, including brackets and fasteners, with zinc-rich primer.

2.14 FINISHES - STEEL & IRON

- A. Shop prime paint all steel and iron items.
 - 1. Exceptions: Galvanize items to be embedded in concrete and items to be embedded in masonry.
 - 2. Exceptions: Items indicated to be galvanized on Drawings.
- B. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
- C. Prepare surfaces to be primed in accordance with SSPC-SP3.
- D. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- E. Prime Painting: One coat.

- F. Galvanizing of Steel Members: Hot-dip galvanize after fabrication to ASTM A153/A153M for steel and iron hardware and to ASTM A123/A123M requirements for other steel and iron products. Provide minimum 1.7 oz/sq ft galvanized coating.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
 - 2. Spangles must be 5mm or less in all applications.

2.15 FINISHES - ALUMINUM

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

2.16 FABRICATION TOLERANCES

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

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Furnish setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.3 INSTALLATION

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- D. Obtain approval prior to site cutting or making adjustments not scheduled.
- E. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

- F. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- G. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- H. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - 1. Extruded Aluminum: Two coats of clear lacquer.

3.4 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.
- C. Anchor shelf angles securely to existing construction with expansion anchors.
- D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installation of Bearing and Leveling Plates" Article.
 - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.5 INSTALLATION OF METAL LADDERS

- A. Secure ladders to adjacent construction with the clip angles attached to the stringer.
- B. Install brackets as required for securing of ladders welded or bolted to structural steel or built into masonry or concrete

3.6 INSTALLATION OF LOOSE BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.
 - 1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.7 REPAIRS

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
 - 2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

3.8 TOLERANCES

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

C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION 05 50 00

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SECTION 05 51 00
METAL STAIRS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Prefabricated (Pre-designed) steel stairs with concrete-filled treads (enclosed fire stairs).
- B. Prefabricated stairs.
- C. Structural steel stair framing and supports.
- D. Handrails and guards for prefabricated steel stairs.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete fill in stair pans.
- B. Section 05 50 00 - Metal Fabrications.
- C. Section 05 73 00 - Decorative Metal Stairs and Railings: for exposed decorative railings on stairs and ramps.
- D. Section 09 22 16 - Non-Structural Metal Framing: for metal backing for anchoring r
- E. Section 09 90 00 - Paints, Stains, & Coatings: Painting for primers and paint finish.

1.3 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- C. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- E. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.
- F. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.
- G. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength; 2023.
- H. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
- I. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
- J. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 COORDINATION

- A. A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for metal stairs.
 - 1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.
 - 2. Deliver such items to Project site in time for installation.

- C. Coordinate locations of hanger rods and struts with other work so they do not encroach on required stair width and are within fire-resistance-rated stair enclosure.
- D. Schedule installation of railings and guards so wall attachments are made only to completed walls.
 - 1. Do not support railings and guards temporarily by any means that do not satisfy structural performance requirements.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide Shop primer and paint products.
- C. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- D. Delegated-Design Submittal: For stairs, railings and guards, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. For installed products indicated to comply with performance requirements and design criteria, submit analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Submit calculations with shop drawings for concurrent review.

1.6 QUALITY ASSURANCE

- A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located, or personnel under direct supervision of such an engineer.
- B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and dated no more than 12 months before start of scheduled welding work.
- C. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.
 - 1. Preassembled Stairs: Commercial class for enclosed fire stairs.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Prefabricated Metal Stairs:
 - 1. Cutting Edge Steel; Cutting Edge Stair: www.cesteel.com/#sle.
 - 2. Lapeyre Stair, Inc; _____: www.lapeyrestair.com/#sle.
 - 3. Pacific Stair Corporation; _____: www.pacificstair.com/#sle.

2.2 PERFORMANCE REQUIREMENTS

- A. A.Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design stairs, including attachment to building construction.
- B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform Load: 100 lbf/sq. ft..
 - 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.

4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.
- C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
 - b. Uniform load of 50 lbf/sq ft applied horizontally.
 - c. Infill load and other loads need not be assumed to act concurrently.

2.3 METAL STAIRS - GENERAL

- A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to building structure.
 1. Regulatory Requirements: Provide stairs and railings that comply with most stringent requirements of local, state, and federal regulations; where requirements of Contract Documents exceed those of regulations, comply with Contract Documents.
 2. Handrails: Comply with applicable accessibility requirements of ADA Standards.
 3. Structural Design: Provide complete stair and railing assemblies that comply with the applicable local code.
 4. Dimensions: As indicated on drawings.
 5. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
 6. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
 7. Separate dissimilar metals using paint or permanent tape.
- B. Metal Jointing and Finish Quality Levels:
 1. Architectural: All joints as inconspicuous as possible, whether welded or mechanical.
 - a. Welded Joints: Continuously welded and ground smooth and flush.
 - b. Mechanical Joints: Butted tight, flush, and hairline; concealed fastenings only.
 - c. Exposed Edges and Corners: Eased to small uniform radius.
 - d. Metal Surfaces to be Painted: Sanded or ground smooth, suitable for highest quality gloss finish.
- C. Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.
- D. Anchors and Related Components: Same material and finish as item to be anchored, except where specifically indicated otherwise; provide all anchors and fasteners required.

2.4 PREFABRICATED STAIRS

- A. Prefabricated Egress Stairs: Welded unit, factory fabricated to greatest degree practical and in the largest components possible.

1. Design Requirements: Comply with structural design criteria stated elsewhere in this section and applicable local code.
 - a. Comply with ADA Standards.
 - b. Comply with applicable sections of the IBC.
2. Materials: Manufacturer's standard steel tubes, plates, bars, shapes, sheets, wire and mesh that comply with requirements of MATERIALS article of this section.
 - a. Rails: Manufacturer's standard rails.
 - 1) Guardrails: 42 inches high.
 - 2) Handrails: 30 inches to 38 inches high.
 - 3) Infill: Manufacturer's standard pickets.
 - b. Treads: Manufacturer's standard concrete pan.
 - c. Finish: Powder coat; color to be selected by Architect from manufacturer's standard range.

2.5 HANDRAILS AND GUARDS

- A. Wall-Mounted Rails: Round pipe or tube rails unless otherwise indicated.
 1. Outside Diameter: 1-1/4 inch, minimum, to 1-1/2 inches, maximum.
- B. Guards:
 1. Top Rails: Round pipe or tube rails unless otherwise indicated.
 - a. Outside Diameter: 1-1/4 inch, minimum, to 1-1/2 inches, maximum.
 2. Infill at Picket Railings: Vertical pickets.
 - a. Horizontal Spacing: Maximum 4 inches on center.
 - b. Material: Solid steel bar.
 - c. Shape: Square.
 - d. Size: 1/2 inch square.
 - e. Top Mounting: Welded to underside of top rail.
 - f. Bottom Mounting: Welded to top surface of stringer.
 3. End and Intermediate Posts: Same material and size as top rails.
 - a. Horizontal Spacing: As indicated on drawings.
 - b. Mounting: Welded to top surface of stringer.

2.6 MATERIALS

- A. Steel Sections: ASTM A36/A36M.
- B. Steel Tubing: ASTM A500/A500M or ASTM A501/A501M structural tubing, round and shapes as indicated.
- C. Pipe: ASTM A53/A53M Grade B Schedule 40, black finish.
- D. Concrete Fill: See Section 03 30 00.

2.7 ACCESSORIES

- A. Steel Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, and galvanized to ASTM A153/A153M where connecting galvanized components.
- B. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. When field welding is required, clean and strip primed steel items to bare metal.

3.3 INSTALLATION

- A. Install components plumb and level, accurately fitted, free from distortion or defects.
- B. Provide anchors, plates, angles, hangers, and struts required for connecting stairs to structure.
- C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- D. Provide welded field joints where specifically indicated on drawings. Perform field welding in accordance with AWS D1.1/D1.1M.
- E. Other field joints may be either welded or bolted provided the result complies with the limitations specified for jointing quality levels.
- F. Obtain approval prior to site cutting or creating adjustments not scheduled.
- G. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.4 TOLERANCES

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

END OF SECTION 05 51 00

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**SECTION 05 70 00
DECORATIVE METAL**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Decorative metal extrusions, plates, and other trim pieces.
- B. Waxed steel plate wall panels at Craig Hall lobby and at the north and south vestibules.
- C. Waxed steel plate ceiling panels at Craig Hall north and south vestibules.
- D. Clear sealer for steel plates.

1.2 RELATED REQUIREMENTS

- A. Section 05 50 00 - Metal Fabrications.
- B. Section 05 71 00 - Decorative Metal Stairs.
- C. Section 05 73 00 - Decorative Metal Railings.
- D. Section 09 21 16 - Gypsum Board Assemblies: Placement of backing plates in stud wall construction.

1.3 REFERENCE STANDARDS

- A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2020.
- B. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- F. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- G. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2024.
- H. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- I. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- J. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.
- K. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2023, with Editorial Revision.
- L. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2023.
- M. ASTM B85/B85M - Standard Specification for Aluminum-Alloy Die Castings; 2018, with Editorial Revision.
- N. ASTM B211/B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire; 2019.
- O. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

- P. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- Q. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
- R. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength; 2023.
- S. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021.
- T. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
- U. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; 2014, with Errata (2020).
- V. AWS D1.6/D1.6M - Structural Welding Code - Stainless Steel; 2017, with Amendment (2021).
- W. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).

1.4 COORDINATION

- A. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate elevations and sections, details of profile, dimensions, sizes, connection attachments, anchorage, size and type of fasteners, and accessories. Indicate anchor and joint locations, brazed connections, transitions, and terminations.
- C. Installer's qualification statement.
- D. Welders' qualification statement.
- E. Samples for Verification: For each type of exposed finish.
 - 1. Sections of linear shapes.
 - 2. Waxed steel plate with finish.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with not less than three years of documented experience.
- B. Installer Qualifications:
 - 1. Installer specialized in work of type specified with at least three years of documented experience and approved by manufacturer.
- C. Welder Qualifications: Welding processes and welding operators certified in accordance with AWS B2.1/B2.1M no more than 12 months before start of scheduled welding work.

1.7 MOCK-UPS

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Provide mock-up of assembly, 1 foot long by 1 foot wide, illustrating each type of material, cladding, and finish.
- C. Locate where directed by Architect.
- D. Subject to compliance with requirements, approved mock-up may remain as part of work.

- E. Pre-installation Conference: Conduct conference at Project site with decorative metal, Installer, Contractor, Architect, Mechanical Engineer and other interested parties to review procedures, schedules, and coordination of installation of other elements of the work.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in factory-provided protective coverings and packaging.
- B. Protect materials against damage during transit, delivery, storage, and installation at site.
- C. Inspect materials for damage upon delivery. Replace damaged and unrepairable materials. Ensure replacement materials are indistinguishable from undamaged parts and finishes.
- D. Prior to installation, store materials and components under cover in a dry location.
- E. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

1.9 FIELD CONDITIONS

- A. Maintain ambient temperature of space at minimum 65 degrees F and maximum 95 degrees F for 24 hours before, during, and after installation.

1.10 COORDINATION

- A. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 PRODUCTS

2.1 MATERIALS

- A. General: Provide sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections exposed to view on finished units.
- B. Aluminum Components: ASTM B221 or ASTM B221M.
 - 1. Tubes: Schedule 40 pipe.
 - 2. Extruded Aluminum: ASTM B221 or ASTM B221M, 6063 alloy, T6 temper.
 - 3. Sheet Aluminum: ASTM B209/B209M, 5052 alloy, H32 or H22 temper.
 - 4. Aluminum-Alloy Bars: ASTM B211/B211M, 6061 alloy, T6 temper.
 - 5. Aluminum-Alloy Die Castings: ASTM B85/B85M, A356 alloy, T6 temper.
 - 6. Sheet Thickness: 1/8 inch, minimum.
 - 7. Welding Materials: Comply with AWS D1.2/D1.2M.
- C. Steel Components:
 - 1. Sections, Shapes, Plate and Bar: ASTM A36/A36M.
 - 2. Ungalvanized Steel Sheet: Hot- or cold-rolled, except use cold-rolled where finished work will be exposed to view.
 - a. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Designation CS (commercial steel).
 - b. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Designation CS (commercial steel).
 - 3. Galvanized Steel Sheet: ASTM A653/A653M, Structural Steel (SS) Grade 33/230 with G40/Z120 coating.
 - 4. Iron Castings: ASTM A47/A47M, malleable.

5. Sheet Thickness: 11 gauge, 0.120 inch.
6. Welding Materials: Comply with AWS D1.1/D1.1M.
- D. Stainless Steel Components:
 1. Section, Plates: ASTM A666, Type 304.
 2. Stainless Steel Bars, Shapes and Moldings: ASTM A276/A276M, Type 304.
 3. Sheet Thickness: 11 gauge. 0.120 inch.
 4. Welding Materials: Comply with AWS D1.6/D1.6M.

2.2 FABRICATION

- A. Fit and shop assemble items in largest practical sections for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- D. Continuously seal joined members by intermittent welds and plastic filler.
- E. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- F. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.
- G. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.
- H. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.
- I. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- J. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.
- K. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
- L. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.
- M. Comply with AWS for recommended practices in shop welding. Weld behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded joints of flux, and dress exposed and contact surfaces.
 1. Where welding cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 Welds: no evidence of a welded joint

2.3 FABRICATION TOLERANCES

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

2.4 FINISHES

- A. General: Comply with NAAMM AMP 500-06.

1. Complete mechanical finishes before fabrication. After fabrication, finish joints, bends, abrasions, and surface blemishes to match sheet.
 2. Protect mechanical finishes on exposed surfaces from damage.
 3. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
 4. Appearance: Limit variations in appearance of adjacent pieces to one-half of range represented in approved samples. Noticeable variations in same piece are not acceptable. Install components within range of approved samples to minimize contrast.
- B. Aluminum Finishes:
1. Class I Clear Anodized Finish: AAMA 611 AA-M12C22A41, clear anodic coating, minimum 0.7 mil, 0.007 inch thick.
 2. Class I Color Anodized Finish: AAMA 611 AA-M12C22A44, electrolytically deposited colored anodic coating, minimum 0.7 mil, 0.007 inch thick.
 3. High Performance Organic Coatings: AAMA 2604; multiple coats, thermally cured fluoropolymer system.
 4. Colors: Custom colors to match architect's samples. Colors may include exotic colors or metallic finishes.
 5. Number of Colors Required: Two (2).
- C. Steel Finishes:
1. Galvanize in accordance with ASTM A123/A123M.
 2. Coated Steel: Clean surface in accordance with SSPC-SP 1 before applying coating.
 3. Primer: Compatible with organic coating; shop-applied.
 4. Baked-Enamel Finish: Manufacturer's standard two-coat baked-enamel finish; topcoat minimum dry film thickness of 1 mil, 0.01 inch. Total minimum dry film thickness of 2 mils, 0.02 inch.
 5. Powder-Coat Finish: Manufacturer's standard thermosetting polyester or acrylic urethane powder coating; minimum cured-film thickness of 1.5 mils, 0.015 inch.
 6. Color: As selected by Architect from manufacturer's standard range.
 7. **Clear Sealer for steel plate:** clear, air-drying, two part water based polyurethane sealer that provides a strong under-film tarnish protection, superior resistance to UV light, and remarkable resistance in salty air environments. Anti-graffiti coating and used for exterior metal applications.
 - a. Hydo Clear, matte formula by Sculpt Nouveau or equal.
- D. Stainless Steel Finishes:
1. Remove tool marks, die marks, and stretch lines before finishing.
 2. Dull Satin: No.6.
 3. Directional Finishes: Run grain with long dimension of each item.
 4. After polishing, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.5 ACCESSORIES

- A. Anchors and Fasteners: Provide anchors, fasteners, and other attachment devices required to attach to structure. Ensure attachment devices are of same material as components unless indicated otherwise.
1. Steel Fasteners: ASTM F3125/F3125M, Type 1, galvanized in accordance with ASTM A153/A153M.
 2. Carbon Steel Fasteners: ASTM A307.
 3. Stainless Steel Fasteners: Type 304.

- 4. Exposed Fasteners: Flush countersunk screws or bolts; consistent with design of railing; provide only where exposed fasteners are unavoidable.
- B. Hydraulic Expansion Cement: ASTM C1107/C1107M.
- C. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- D. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- E. DEpoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- F. Intermediate Coats and Topcoats for Steel: Provide primers that comply with Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
- G. Epoxy Intermediate Coat for Steel: Complying with MPI#77 and compatible with primer and topcoat.
- H. Polyurethane Topcoat for Steel: Complying with MPI#72 and compatible with undercoat.
- I. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- J. Bituminous Coating: Cold-applied asphalt mastic, noncorrosive compound free of asbestos, sulfur, and other deleterious impurities; 0.015 inch dry film thickness per coat.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrate and site conditions are acceptable and ready to receive work.
- B. Verify field dimensions of locations and areas to receive work.
- C. Notify Architect immediately of conditions that would prevent satisfactory installation.
- D. Do not proceed with work until detrimental conditions have been corrected.

3.2 PREPARATION

- A. Protect existing work.
- B. Clean surfaces to receive units. Remove materials and substances detrimental to installation.

3.3 INSTALLATION

- A. Comply with manufacturer's drawings and written instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects, and with tight joints, except where necessary for expansion.
- C. Anchor securely to structure.
- D. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.
- E. Isolate dissimilar materials with bituminous coating, bushings, grommets, or washers to prevent electrolytic corrosion.
- F. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.
- G. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.

- H. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
- I. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.
- J. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
 - 1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.
- K. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

3.4 CLEANING

- A. Remove protective film from exposed metal surfaces.
- B. Metal: Clean exposed metal finishes with potable water and mild detergent, in accordance with manufacturer recommendations; do not use abrasive materials or chemicals, detergents, or other substances that may damage the material or finish.

3.5 PROTECTION

- A. Protect installed components and finishes from damage after installation.
- B. Repair damage to exposed finishes to be indistinguishable from undamaged areas.
- C. If damage to finishes and components cannot be repaired to be indistinguishable from undamaged finishes and components, replace damaged items.

END OF SECTION 05 70 00

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SECTION 05 73 11
DECORATIVE METAL AND GLAZED METAL RAILINGS - VIVA

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Railing and handrail assemblies.
- B. Metal railings.
- C. Structural glass railings.
- D. Integral lighting system for handrails.
- E. Metal panel railings.
- F. Exterior stainless-steel handrails.

1.2 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry: for wood blocking for anchoring railings.
- B. Section 05 71 00 - Decorative Metal Stair.
- C. Section 09 22 16 - Non-Structural Metal Framing: for metal backing for anchoring railings.
- D. Section 08 80 00 - Glazing: for all glass and glazing work required of decorative metal railings.
- E. Section 09 66 23 - Resinous Matrix Terrazzo Flooring: for precast epoxy-resin terrazzo units.
- F. Section 09 90 00 - Paints, Stains, and Coatings: for shop primers and other paint systems to be provided as part of this section.

1.3 REFERENCE STANDARDS

- A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2020.
- B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- E. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2024.
- F. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- G. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.
- H. ASTM A554 - Standard Specification for Welded Stainless Steel Mechanical Tubing; 2021.
- I. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.
- J. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.
- K. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- L. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- M. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2018.
- N. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
- O. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass; 2019.

- P. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength; 2023.
- Q. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
- R. AWS D1.6/D1.6M - Structural Welding Code - Stainless Steel; 2017, with Amendment (2021).
- S. ICC-ES ESR-4405 - Evaluation Report for Shoe Glass Panel Railing System; 2022, with Editorial Revision.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Schedule and conduct a preinstallation meeting one week before starting work of this section. Attendees shall include, but not be limited to:
 - 1. Contractor.
 - 2. Manufacturer's representative.
 - 3. Architect.
 - 4. Owner's representative.
 - 5. Other subcontractors of adjacent work.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's product data, including description of materials, components, and finishes.
- C. ICC Certification: Submit documentation from manufacturer showing specified systems comply with ICC-ES ESR-4405.
- D. Shop Drawings: Indicate railing system elevations and sections, details of profile, dimensions, sizes, connection attachments, anchorage, size and type of fasteners, and accessories. Indicate anchor and joint locations, transitions, and terminations.
- E. Samples: Submit one (1) of each item below for each type and condition shown.
 - 1. Glass: 12 inches by 12 inches, showing color, thickness and edge condition.
 - 2. Railing: 12-inch long section of handrail showing color, finish and connection detail.
 - 3. Cladding: 6-inch by 6-inch sample of each type of cladding, showing finish.
- F. Manufacturer's qualification statement.
- G. Single-source qualification statement.
- H. Installer's qualification statement.
- I. Maintenance Data: Manufacturer's instructions for care and cleaning.
- J. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with not less than fifteen years of documented experience.
 - 1. Provide certified glass products through ANSI accredited certifications that include plant audits and independent laboratory performance testing.
- B. Installer Qualifications: Company specializing in installing decorative railing systems and acceptable to manufacturer.
- C. Source Limitations for Laminated Glass: Obtain laminated-glass units from one manufacturer using the same type of glass lites and interlayers for each type of unit indicated.
- D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."
- E. Safety Glazing Labeling: Permanently mark glass 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. Locate in bottom right corner of each panel unless otherwise noted. Coordinate with Architect.
- F. Product Options: Information on Drawings and in Specifications establishes requirements for system's 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 structural analysis, preconstruction testing, field testing, and in-service performance.
 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

1.7 MOCK-UPS

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 1. Build mockups for each form and finish of railing consisting of handrail, structural glazing, and anchorage system components that are full height and are not less than 24 inches in length.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in factory-provided protective coverings and packaging.
- B. Protect materials against damage during transit, delivery, storage, and installation at site.
- C. Inspect materials upon delivery for damage. Replace damaged items.
- D. Prior to installation, store materials and components under cover in a dry location.

1.9 FIELD CONDITIONS

- A. Do not install railings until project is enclosed and ambient temperature of space is minimum 65 degrees F and maximum 95 degrees F.
- B. Maintain ambient temperature of space at minimum 65 degrees F and maximum 95 degrees F for 24 hours before, during, and after railing installation.
- C. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 WARRANTY

- A. Warranty: Manufacturer's standard one-year warranty against defects in materials, fabrication, finishes, and installation commencing on Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. C.R. Laurence Co., Inc. (CRL): www.crlaurence.com or comparable products of other manufacturers approved by the Architect.

2.2 RAILING SYSTEMS, GENERAL

- A. Factory- or shop-fabricate to suit project conditions, for proper connection to building structure, and in largest practical sizes for delivery to site.
- B. Handrails: Comply with applicable accessibility requirements of ADA Standards.
- C. Joints: Tightly fitted and secured, machined smooth with hairline seams.
- D. Field Connections: Provide sleeves, anchors, and other devices required for site assembly and installation.
- E. Welded Joints: Make visible joints butt tight, flush, and hairline; use methods that avoid discoloration and damage of finish; grind smooth, polish, and restore to required finish.

2.3 STRUCTURAL GLASS RAILINGS

- A. Structural Glass Railing System, Base-Mounted: Engineered, base-shoe supported railing system with structural glass.
- B. Basis of Design –CLR 98L68 series square profile surface mount mill aluminum base shoe as manufactured by C.R. Laurence Co., Inc. (CRL), or equal.
 - 1. Coordinate carefully with glass guardrails.
 - 2. Install per manufacturer's instructions and according to the Drawings.
 - 3. Finish: Mill Aluminum.
 - 4. Cladding: CRL 20 Ga Cladding, Powder coat finish to match Architect's sample set with CRL AT234 - .045" x 3/4" VHB tape. See drawing for custom cladding size.
 - 5. Filler Strip:
 - a. CRL SLBSG Series - "Drop Side" push in safety glazing gasket
 - b. CRL LBSG Series – Black top roll in rubber glazing gasket
 - 6. End Caps: Provide matching end caps at termination of shoe where exposed to view. End caps to be attached to shoe assembly using screws and concealed brackets.
 - 7. Glazing pocket: Sized to accommodate glass thickness required.
 - 8. Fasteners: As supplied by manufacturer for attachment of shoe to building structure.
 - a. Size as required based on loading and code requirements.
 - b. All fasteners to be fully concealed from view under cover.

2.4 INTEGRAL LIGHTING SYSTEM FOR HANDRAILS

- A. Metal Railing with Modular Installed Lighting:
 - 1. Product: See Lighting Schedule.
 - 2. Power: See Lighting Schedule.
 - a. Input: 120/277 V AC.
 - b. Output: 12V DC.

2.5 MATERIALS AND FINISHES

- A. Aluminum Components: ASTM B221 or ASTM B221M.
 - 1. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
 - 2. Extruded Bars and Shapes, Including Extruded Tubing: ASTM B 221, Alloy 6063-T5/T52.
 - 3. Extruded Structural Pipe and Round Tubing: ASTM B 429/B 429M, Alloy 6063-T6.
 - a. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.

4. Drawn Seamless Tubing: ASTM B 210, Alloy 6063-T832.
5. Plate and Sheet: ASTM B 209, Alloy 6061-T6
6. Die and Hand Forgings: ASTM B 247, Alloy 6061-T6.
7. Castings: ASTM B 26/B 26M, Alloy A356.0-T6
 - a. Clear Anodized Finish: Class I, AAMA 611 AA-M12C22A41, clear anodic coating with electrolytically deposited organic seal; not less than 0.7 mils (0.007 inch) thick.
 - b. Color Anodized Finish: Class I, AAMA 611 AA-M12C22A44, electrolytically deposited colored anodic coating not less than 0.7 mils (0.0007 inch) thick.
- B. Steel Components:
 1. Sections, Shapes, Plates, and Bars: ASTM A36/A36M.
 2. Tubing: ASTM A501/A501M structural tubing; round, and shapes as indicated.
 3. Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, and galvanized to ASTM A153/A153M where connecting galvanized components.
 4. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
 5. Powder Coat Finish: Manufacturer's recommended system.
- C. Stainless Steel Components:
 1. ASTM A666, Type 304 or Type 316.
 2. Stainless Steel Tubing: ASTM A554, Type 304 or Type 316.
 3. Stainless Steel Bars, Shapes, and Moldings: ASTM A276/A276M, Type 304 or Type 316.
 4. Stainless Steel Finish: No.6 Satin.

2.6 GLASS AND GLAZING MATERIALS

- A. Laminated Safety Glass: ASTM C1172 and Category II of CPSC 16 CFR 1201 or ANSI Z97.1. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
 1. Interlayer: Interlayer material as indicated, clear or in colors, and of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.
 2. Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets as follows:
 - a. Laminate lites with polyvinyl butyral interlayer in autoclave with heat plus pressure.
 - b. Laminate lites with laminated glass manufacturer's standard cast-in-place and cured transparent resin interlayer.
 3. Interlayer Color: Clear unless otherwise indicated.
 4. Kind FT tempered glass: Comply with ASTM C1048 and have minimum Modulus of Rupture (Fr) \geq 24,000 psi (165 Mpa).
 5. Fabrication Tolerances:
 - a. No delamination or air bubbles shall be permitted.
 - b. Edge Shift Tolerance:
 - c. Tampered – Visible edge
 - 1) Edge length greater than 0mm: +/- 1.0mm max
 - d. Overall thickness tolerance: +/- 0.5mm max
 - e. Interlayer edge finish: All interlayer joints to have a smooth clean bright finish recessed from finished edge.

6. General Performance: Laminated glazing assemblies attached to decorative metal framing 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.
7. Structural Performance: Laminated glazing assemblies attached to decorative metal framing shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
 - a. Seismic Loads: As indicated on Drawings.
 - b. Deflection Limits: Deflection normal to glazing plane is limited to 1/175 of clear span or 3/4 inch, whichever is smaller.
8. Delegated Design: Design laminated glazing assemblies for attachment to decorative metal framing, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated
- B. Fully Tempered Safety Glass: ASTM C1048; Condition A (uncoated), Type 1 (transparent flat glass), transparent, Class 1, Quality Q3, unless otherwise indicated.
- C. **Glass Type G3: 11/16" THK Clear Tempered Laminated**
 1. Two plies fully tempered (where indicated) float glass.
 2. Thickness: 5/16" (8mm) fully tempered glass x .060 (1.52mm) polyvinyl butyral (PVB) x 5/16" (8mm) fully tempered glass.
 - a. Interlayer to comply with both:
 - 1) ANSI Z97.1-1984
 - 2) CPSC 16 CFR 1201
 3. Exposed Edges: Machine ground and flat polished.
 4. Butt Edges: Flat ground.
 5. Corner Edges: Mitered-joint corners with edges machine ground and polished
 6. Location: As indicated in the contract drawings.
 7. **Basis-of-Design Product:** Subject to compliance with requirements, provide CR Laurence.
- D. Laminated Glass Fabrication
 1. Provide holes and cutouts in glass to receive hardware, fittings, and accessory fittings before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.
 - a. Fully temper glass using horizontal (roller-hearth) process, and fabricate so that when glass is installed, roll-wave distortion is parallel with bottom edge of door or lite.
 2. Factory assemble components and factory install hardware and fittings to greatest extent possible.
- E. Safety Glazing Labeling: Permanently mark glass with certification label of the SGCC. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- F. Glazing Gaskets for Glass Infill Panels: Glazing gaskets and related accessories recommended or supplied by railing manufacturer for installing glass infill panels in post-supported railings.

2.7 HANDRAIL BRACKET

- A. Basis of Design – Malibu Series Glass & Wall Mounted Hand Railing System as manufactured by C.R. Laurence Co., Inc. (CRL), or equal.
- B. Finish: Brushed Stainless

2.8 ACCESSORIES

- A. Anchors and Fasteners: Provide anchors and other materials as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable, provide flush countersunk fasteners.
 - 1. For anchorage to concrete, provide inserts to cast into concrete for bolt anchors.
 - 2. For anchorage to masonry, provide brackets to embed in masonry for bolt anchors.
 - 3. For anchorage to stud walls, provide backing plates for bolt anchors.
 - 4. Exposed Fasteners: No exposed bolts or screws.
- B. FASTENERS
 - 1. Fastener Materials: Unless otherwise indicated, provide the following:
 - a. Stainless-Steel Components: Type 304 stainless-steel fasteners.
 - b. Uncoated Steel Components: Plated-steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed; Type 304 stainless-steel fasteners where exposed.
 - c. Galvanized-Steel Components: Plated-steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
 - d. Dissimilar Metals: Type 304 stainless-steel fasteners.
 - 2. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
 - 3. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless otherwise indicated .
 - a. Provide countersunk square drive flat-head machine screws for exposed fasteners unless otherwise indicated.
 - 4. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193.
 - a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
 - b. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.
- C. Carbon Steel Bolts and Nuts: ASTM A307.
- D. Hydraulic Expansion Cement: ASTM C1107/C1107M.
- E. Concrete Adhesive Type Anchors: Comply with ICC-ES AC308.
- F. Bituminous Coating: Cold-applied asphalt mastic, noncorrosive compound free of asbestos, sulfur, and other deleterious impurities; 0.015 inch dry film thickness per coat.
- G. Finish Touch-Up Materials: As recommended by manufacturer for field application.
- H. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
- I. Shop Primers: Provide primers that comply with Division 09 painting Sections.
- J. Electrical Components: Provide internal, fluorescent light fixtures and electrical components, required as part of illuminated railings, that comply with NFPA 70, are listed and labeled by a qualified testing agency as defined in NFPA 70, and are marked for intended location and application.

2.9 FABRICATION

2.10 GENERAL: FABRICATE STAIRS AND RAILINGS TO COMPLY WITH REQUIREMENTS INDICATED FOR DESIGN, DIMENSIONS, MEMBER SIZES AND SPACING, DETAILS, FINISH, AND ANCHORAGE.

- A. Assemble stair and railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form work true to line and level with accurate angles and surfaces.
- D. In addition to special care used to handle and fabricate decorative stair and rail, comply with the following:
 - 1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, and roughness.
 - 2. Grind sheared, punched, and flame-cut edges of stairs to remove burrs and provide smooth surfaces and edges.
 - 3. Fabricate stairs with exposed surfaces free of mill marks, including rolled trade names and stamped or raised identification.
 - 4. Fabricate stairs with exposed surfaces free of seams to maximum extent possible.
 - 5. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
 - 6. All exposed welds uniform in size with smooth face, contoured and blended.
 - 7. Fabricate with piece marks fully hidden in the completed structure or made with media that permits full removal after erection.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded or connections unless otherwise indicated.
- H. Weld Connections for Decorative Stair: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work, and comply with the following:
 - 1. Use weld sizes, fabrication sequence, and equipment for stairs that limit distortions to allowable tolerances.
 - 2. Provide continuous welds of uniform size and profile where stair is welded.
 - 3. Grind butt and groove welds flush to adjacent surfaces within tolerance of plus 1/16 inch, minus 0 inch (plus 1.5 mm, minus 0 mm) for stair construction.
 - 4. Remove backing bars or runoff tabs; back-gouge and grind steel smooth.
 - 5. At locations where welding on the far side of an exposed connection of stair structure occurs, grind distortions and marking of the steel to a smooth profile aligned with adjacent material.
 - 6. Make fillet welds for stair oversize and grind to uniform profile with smooth face and transition, contoured and blended.
- I. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 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 flux immediately.
 4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds; no evidence of a welded joint.
- J. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
- K. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- L. Form changes in direction as follows:
1. As detailed.
- M. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- N. Close exposed ends of hollow railing members with prefabricated end fittings.
- O. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is 1/4 inch or less.
- P. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and to prevent bracket or fitting rotation and crushing of substrate.
- Q. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

2.11 GLAZING PANEL FABRICATION

- A. General: Fabricate to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.
1. Clean-cut or flat-grind edges at butt-glazed joints, whether they are designated to be finished with or without sealant, to produce square edges with slight chamfers at junctions of edges and faces
 2. Grind smooth exposed edges, including those at open joints, to produce square edges with slight chamfers at junctions of edges and faces.
- B. Structural Glass Balusters: Field glaze glass panels into aluminum shoe molding following manufacturer's instructions.
- C. Infill Panels: Provide tempered glass panels.
- D. Include accessory items indicated or as required to complete work of this section.

2.12 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.13 2 ALUMINUM FINISHES

- A. Mechanical Finish: AA-M3x; sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 120- and 320-grit abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.
- B. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2.14 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
- C. Run grain of directional finishes with long dimension of each piece.
- D. Dull Satin Finish: No. 6.
- E. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.15 STEEL AND IRON FINISHES

- A. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, but galvanize anchors to be embedded in exterior concrete or masonry.
- B. Surface Preparation for Steel: 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 6/NACE No. 3, "Commercial Blast 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. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2. 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.
 - 3. Color: As selected by Architect from manufacturer's full range.
- D. Powder-Coat Finish: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:
 - 1. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
 - 3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils.
 - 4. Color: As selected by Architect from manufacturer's full range.

PART 3 EXECUTION

3.1 EXAMINATION

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

- B. Verify field dimensions of locations and areas to receive work.
- C. Notify Architect immediately of conditions that would prevent satisfactory installation.
- D. Do not proceed with work until detrimental conditions have been corrected.
- E. Furnish components to be installed in other work to installer of that other work, including but not limited to blocking, sleeves, inserts, anchor bolts, embedded plates, and supports for attachment of anchors.

3.2 PREPARATION

- A. Review installation drawings before beginning installation. Coordinate diagrams, templates, instructions, and directions for installation of anchorages and fasteners.
- B. Clean surfaces to receive units. Remove materials and substances detrimental to the installation.

3.3 INSTALLATION

- A. Use manufacturer's approved installer.
- B. Comply with manufacturer's drawings and written instructions.
- C. Install components plumb and level, accurately fitted, free from distortion or defects, and with tight joints, except where necessary for expansion.
- D. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- E. Anchor securely to structure.
- F. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.
- G. Weld connections that cannot be shop welded due to size limitations.
 - 1. Weld in accordance with AWS D1.1/D1.1M.
 - 2. Weld stainless steel in accordance with AWS D1.6/D1.6M.
 - 3. Match shop welding and bolting.
 - 4. Clean welds, bolted connections, and abraded areas.
 - 5. Touch up shop primer and factory-applied finishes.
 - 6. Repair galvanizing with galvanizing repair paint in accordance with ASTM A780/A780M.
- H. Isolate dissimilar materials with bituminous coating, bushings, grommets, or washers to prevent electrolytic corrosion.
- I. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 - 1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 - 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

3.4 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.5 INSTALLING GLASS PANELS

- A. Glass-Supported Railings: Install assembly to comply with railing manufacturer's written instructions.
 - 1. Attach base channel to building structure, then adjust spacing of glass panels so gaps between the panels are equal before securing in position.
 - 2. Adjust spacing of glass panels so gaps between panels are equal before securing in position.
 - 3. Erect glass railings under direct supervision of manufacturer's authorized technical personnel.
- B. Post-Supported Glass Railings: Install assembly to comply with railing manufacturer's written instructions and with requirements in other Part 3 articles. Erect posts and other metal railing components, then set factory-cut glass panels. Do not cut, drill, or alter glass panels in field. Protect edges from damage.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance

3.6 ANCHORING POSTS

- A. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Leave anchorage joint exposed with anchoring material flush with adjacent surface.
- C. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For aluminum railings, attach posts as indicated using fittings designed and engineered for this purpose.
 - 2. For copper-alloy railings, attach posts as indicated using fittings designed and engineered for this purpose.
 - 3. For stainless-steel railings, weld flanges to posts and bolt to metal-supporting surfaces.
 - 4. For steel railings, weld flanges to posts and bolt to metal-supporting surfaces.
 - 5. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.7 ATTACHING RAILINGS

- A. Attach handrails to walls with wall brackets except where end flanges are used. Provide brackets with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
 - 1. Use type of bracket with predrilled hole for exposed bolt anchorage.
 - 2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- B. Secure wall brackets and railing end flanges to building construction as follows:
- C. For steel-framed partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.

3.8 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per floor level, noncumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.

- C. Maximum Out-of-Position: 1/4 inch.

3.9 FIELD QUALITY CONTROL

- A. Field Services: Provide the services of the manufacturer for field observation of installation of railings.

3.10 CLEANING

- A. Metal: Clean exposed metal finishes with potable water and mild detergent, in accordance with manufacturer recommendations; do not use abrasive materials or chemicals, detergents, or other substances that may damage the material or finish.
- B. Glass and Glazing: Clean glazing surfaces; remove excess glazing sealant compounds, dirt, and other substances.

3.11 PROTECTION

- A. Repair damage to exposed finishes to be indistinguishable from undamaged areas.
 - 1. If damage to finishes and components cannot be repaired to be indistinguishable from undamaged finishes and components, replace damaged items.

END OF SECTION 05 73 11

**SECTION 06 10 00
ROUGH CARPENTRY**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nonstructural dimension lumber framing.
- B. Wood Sheathing.
- C. Preservative treated wood materials.
- D. Fire retardant treated wood materials.
- E. Communications and electrical room mounting boards.
- F. Concealed wood blocking, nailers, and supports.
- G. Miscellaneous wood nailers, furring, and grounds.

1.2 RELATED REQUIREMENTS

- A. Section 07 25 00 - Weather Barriers: Water-resistive barrier over sheathing.

1.3 DEFINITIONS

- A. Dimensional Lumber: Lumber of **two (2) inches** nominal or greater, but less than **five (5) inches** nominal in least dimension.
- B. Boards or Strips: Lumber of less than two (2) inches nominal size in least dimension.
- C. Exposed Framing: Framing not fully concealed by other construction.
- D. OSB: Oriented strand board.
- E. Timber: Lumber of **five (5) inches** nominal size or greater in least dimension.
- F. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
 - 2. NLGA: National Lumber Grades Authority.
 - 3. SPIB: The Southern Pine Inspection Bureau.
 - 4. WWPA: Western Wood Products Association.

1.4 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- B. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- C. ASTM A563/A563M - Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric); 2021a.
- D. ASTM C557 - Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing; 2003 (Reapproved 2017).
- E. ASTM D2898 - Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing; 2010 (Reapproved 2017).
- F. ASTM D5516 - Standard Test Method for Evaluating the Flexural Properties of Fire-Retardant Treated Softwood Plywood Exposed to Elevated Temperatures; 2018.
- G. ASTM D5664 - Standard Test Method for Evaluating the Effects of Fire-Retardant Treatments and Elevated Temperatures on Strength Properties of Fire-Retardant Treated Lumber; 2017.
- H. ASTM F1667/F1667M - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples; 2021a.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- J. ASTM E488/E488M - Standard Test Methods for Strength of Anchors in Concrete Elements; 2022.

- K. AWC (WFCM) - Wood Frame Construction Manual for One- and Two-Family Dwellings; 2024, with Errata.
- L. AWC WCD1 - DETAILS FOR CONVENTIONAL WOOD FRAME CONSTRUCTION; 2001.
- M. AWPA U1 - Use Category System: User Specification for Treated Wood; 2024.
- N. PS 1 - Structural Plywood; 2023.
- O. PS 2 - Performance Standard for Wood Structural Panels; 2018.
- P. PS 20 - American Softwood Lumber Standard; 2021.

1.5 ACTION SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for 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 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.
 - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 - 3. For fire-retardant treatments in lumber, 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 D5664.
 - 4. For fire-retardant treatments in sheathing, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5516.
 - 5. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
 - 6. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.6 INFORMATION SUBMITTALS

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

1.7 QUALITY ASSURANCE

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

1.8 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.
 - 2. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 15 percent for two (2) inch nominal thickness or less, 19 percent for more than two (2) inch nominal thickness, unless indicated otherwise.
- C. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
 - 1. Allowable design stresses, as published by manufacturer, shall meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

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

2.3 CONSTRUCTION PANELS

- A. Roof Sheathing: Plywood; PS 1 type.
 - 1. Panel requirements, not less than what is required by structural, see Drawings.
 - a. Bond Classification: Exposure 1.
 - b. Grade: Structural I Sheathing.
 - c. Span Rating: 16/0.
 - d. Edge Profile: Tongue and groove.
 - e. Thickness: As needed to comply with requirements specified, but not less than thickness indicated on **Drawings**.
- B. Wall Sheathing: Plywood; PS 1 type.
 - 1. Panel requirements, not less than what is required by structural, see Drawings.
 - a. Bond Classification: Exposure 1.
 - b. Grade: Structural I Sheathing.
 - c. Span Rating: 16/0.

- d. Edge Profile: Square edge.
- e. Thickness: As needed to comply with requirements specified, but not less than thickness indicated on **Drawings**.
- C. Communications and Electrical Room Mounting Boards: PS 1 A-C plywood; not less than 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.

2.4 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
 - 2. Nails, Brads, and Staples: ASTM F1667/F1667M .
 - 3. Power-Driven Fasteners: NES NER-272
 - 4. Bolts: Steel bolts complying with ASTM A307 , Grade A; with ASTM A563/A563M hex nuts and, where indicated, flat washers.
 - 5. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E488/E488M conducted by a qualified independent testing and inspecting agency.
- B. Sill Gasket on Top of Foundation Wall: 1/4 inch thick, plate width, closed cell plastic foam from continuous rolls.
- C. Water-Repellent Preservative: NWWDA-tested and accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chlorpyrifos as its active ingredient.
- D. General Purpose Construction Adhesives: Comply with ASTM C557.
 - 1. Adhesives shall have a VOC content of 70 g/L or less.

2.5 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWWA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 - 1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
 - 2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWWA standards.
- B. Fire Retardant Treatment:
 - 1. Exterior Type: AWWA U1, Category UCFB, Commodity Specification H, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Do not use treated wood in direct contact with the ground.

2. Interior Type A: AWP A U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Treat rough carpentry items as indicated .
 - c. Do not use treated wood in applications exposed to weather or where the wood may become wet.
- C. Preservative Treatment:
 1. Preservative Pressure Treatment of Lumber Above Grade: AWP A U1, Use Category UC3B, Commodity Specification A using waterborne preservative.
 - a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - b. Treat lumber used as wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in contact with roofing, flashing, or waterproofing.
 - c. Treat lumber used as wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
 - d. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
 - e. Treat lumber less than 18 inches above grade.
 - f. Wood floor plates that are installed over concrete slabs-on-grade.
 2. Preservative Pressure Treatment of Plywood Above Grade: AWP A U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative.
 - a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
 - b. Treat plywood in contact with roofing, flashing, or waterproofing.
 - c. Treat plywood in contact with masonry or concrete.
 - d. Treat plywood less than 18 inches above grade.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

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

3.2 FRAMING INSTALLATION

- A. Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

- B. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.
- C. Install structural members full length without splices unless otherwise specifically detailed.
- D. Comply with member sizes, spacing, and configurations indicated, and fastener size and spacing indicated, but not less than required by applicable codes, AWC (WFCM) Wood Frame Construction Manual, and "Details for Conventional Wood Frame Construction," AWC WCD1.
- E. Construct double joist headers at floor and ceiling openings and under wall stud partitions that are parallel to floor joists; use metal joist hangers unless otherwise detailed.
- F. Frame wall openings with two or more studs at each jamb; support headers on cripple studs.

3.3 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- B. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
- C. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
 - 1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
 - 2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.

3.4 ROOF-RELATED CARPENTRY

- A. Coordinate installation of roofing carpentry with deck construction, framing of roof openings, and roofing assembly installation.
- B. Provide wood curb at each roof opening except where prefabricated curbs are specified and where specifically indicated otherwise; form corners by alternating lapping side members.

3.5 INSTALLATION OF CONSTRUCTION PANELS

- A. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using nails, screws, or staples.
 - 1. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
 - 2. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
 - 3. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
 - 4. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

5. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
6. 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.
- B. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and into studs in field of board.
 1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
 2. Install adjacent boards without gaps.
 3. Size: 48 by 96 inches, installed vertically at eight (8) inches above finished floor.

3.6 TOLERANCES

- A. Framing Members: 1/4 inch from true position, maximum.
- B. Variation from Plane, Other than Floors: 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

3.7 CLEANING

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

END OF SECTION 06 10 00

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SECTION 06 16 00
GYP SHEATHING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Gypsum Sheathing.
- B. Sheathing joint and penetration treatment.

1.2 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry.
- B. 07 27 26 Fluid-Applied Membrane Air Barriers

1.3 REFERENCE STANDARDS

- A. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2017.
- B. ASTM C1185 - Standard Test Methods for Sampling and Testing Fiber-Cement Flat Sheet, Roofing and Siding Shingles, and Clapboards; 2023.
- C. ASTM D1037 - Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials; 2012 (Reapproved 2020).
- D. ASTM D1293 - Standard Test Methods for pH of Water; 2018.
- E. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- G. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C; 2024.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide technical data on sheathing and application instructions.
 - 1. For air-barrier and water-resistant glass-mat gypsum sheathing, include manufacturer's technical data and tested physical and performance properties of products.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with minimum three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products above ground in dry ventilated space to protect against moisture. Support stacked products to prevent deformation and allow air circulation.

1.7 FIELD CONDITIONS

- A. When mechanically fastened, do not install cementitious reinforced panel when ambient or conditioned temperature is below 0 degrees F.
- B. Do not apply finish flooring and roofing over cementitious reinforced panel when wet, frozen, or containing frost.
- C. Prior to application of finish flooring and roofing, cementitious reinforced panel or subfloor must be conditioned at same temperature as required for finished flooring for at least 48 hours.

PART 2 PRODUCTS

2.1 SHEATHING

- A. Structural cementitious roof sheathing panels.
 - 1. Size: 48 by 96 inches, nominal.
 - 2. Thickness: 3/4 inch, nominal.
 - 3. Edges: Square.
 - 4. Span: 48 inches, maximum.
 - 5. Fire Resistance: Noncombustible, when tested in accordance with ASTM E136.
 - 6. Surface Burning Characteristics: Flame spread index of 0; smoke developed index of 0; when tested in accordance with ASTM E84.
 - 7. Mold Resistance: Rating of 10, when tested in accordance with ASTM D3273.
 - 8. Density: 75 psf in accordance with ASTM C1185.
 - 9. Weight: 5 psf in accordance with ASTM D1037 at thickness of 3/4 inch.
 - 10. pH Value: 10 when tested in accordance with ASTM D1293.
 - 11. Termite Resistance: 9.8 when tested in accordance with AWPA E1.
- B. Glass-mat-faced gypsum wall sheathing, comply with ASTM C1177/C1177M.
 - 1. Thickness: 5/8 inch.
 - 2. Type: Type X.
 - 3. Edges: Square.
 - 4. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 5. Products:

2.2 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. General: Refer to manufacturer product information for fastener types and requirements.
 - 2. Anchors: Toggle bolt type for anchorage to hollow masonry.
- B. Panel Treatment: Use manufacturer-recommended sealant, transition trips, flashing sheets, termination bars, patching materials, and adhesive tapes at control joints, panel connections, and penetrations.
- C. Sealants:
 - 1. Medium-modulus, low-VOC, polyurethane for use in joints, penetrations, and transition areas.
 - a. USG Corporation; Dymonic 100.
 - 2. Ultra-low modulus silicone for adhering connections to panels.
 - a. USG Corporation; Spectrem 1.
- D. Transition Membrane: Silicone extrusion for expansion joints between panels.
 - 1. USG Corporation; Proglaze ETA Connections.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify roof and floor framing meet deflection criteria noted in drawings, as recommended by manufacturer and local building code requirements.

- B. Examine substrates and adjoining construction.
- C. Replace damaged framing before installation of cementitious panel subfloor. Proceed with installation only after unsatisfactory conditions corrected.

3.2 PREPARATION

- A. Coordinate installation of roof and floor deck construction, framing of openings, and other assembly installation.
- B. Coordinate installation of rough carpentry members specified in other sections.

3.3 INSTALLATION

- A. Select material sizes to minimize waste.
- B. Reuse and clearly separate scrap for use on-site as accessory components, including shims, bracing, and blocking.
- C. Roof Sheathing: Secure panels with long dimension perpendicular to framing members, with ends staggered and over firm bearing.
- D. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using screws.

3.4 CLEANING

- A. Clean material debris, shavings, and sawdust prior to Substantial Completion of project.

3.5 PROTECTION

- A. Do not permit traffic over unprotected floor surface.
- B. Cover sheathing panels by exterior cladding or other weather-resistive barrier. Do not expose panels to elements for more than 12 months after installation. If exposure anticipated past 12 months, apply joint treatments, weather-resistive barrier, or air barrier according to manufacturer's recommendations.

END OF SECTION 06 16 00

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SECTION 06 40 23
INTERIOR ARCHITECTURAL WOODWORKING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior standing and running trim.
 - 2. Architectural wood veneered paneling.
 - 3. Architectural wood veneered cabinets.
 - 4. Wood cabinets for plastic laminate finish.
 - 5. Cabinet hardware.
 - 6. Solid-Surfacing-material countertops and backsplashes.
 - 7. Stone Countertops.
 - 8. Tackboard surfaces.
- B. Related Requirements:
 - 1. Section 06 10 00 "Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view.
 - 2. Section 08 80 00 "Glazing" for glazing requirements that are within the section.

1.3 DEFINITIONS

- A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.
- B. MDF: Medium-density fiberboard.
- C. MDO: Plywood with a medium-density overlay on the face.

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

- A. Product Data:
 - 1. Anchors.
 - 2. Adhesives.
 - 3. Shop finishing materials.
- B. Wood-Preservative Treatment:
 - 1. Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
 - 2. Indicate type of preservative used and net amount of preservative retained.
 - 3. Include chemical-treatment manufacturer's written instructions for finishing treated material and manufacturer's written warranty.
- C. Fire-Retardant Treatment: Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

- D. Waterborne Treatments: For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
- E. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 - 1. Include plans, sections, details, and attachments to other work.
 - 2. Show locations and details of joints.
 - 3. Show direction of veining, grain, or other directional pattern.
 - 4. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 5. Show locations and sizes of cutouts and holes for electrical switches and outlets and other items installed in architectural plastic-laminate cabinets.
- F. Coordination: Submit related shop drawings, specified in another Section simultaneously for approval.
 - 1. Countertops shops, showing all dimensions and indicating how countertops are to be mounted to cabinets.
- G. Samples: For each exposed product and for each color and texture specified.
 - 1. Size: Samples not less than 12 inches square.
- H. Samples for Initial Selection: For each type of product involving selection of colors, profiles, or textures.
 - 1. Shop-applied transparent finishes.
 - 2. Shop-applied opaque finishes.
 - 3. Solid-surfacing materials.
 - 4. Plastic laminates, 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish, with one sample applied to core material and specified edge material applied to one edge.
 - 5. Veneer Leaves: Representative of and selected from flitches to be used for transparent-finished interior architectural woodwork.
 - 6. Exposed cabinet hardware and accessories, one unit for each type and finish.
- I. Samples for Verification:
 - 1. Lumber with or for transparent finish, not less than 5 inches wide by 24 inches long, for each species and cut, finished on 1 side and 1 edge.
 - 2. Lumber and panel products with shop-applied opaque finish, 50 sq. in. for lumber and 8 by 10 inches for panels, for each finish system and color, with 1/2 of exposed surface finished.
 - 3. Solid-surfacing materials, 6 inches square.
 - 4. Stone Countertop, include three or more Samples in each set and show the full range of variations in appearance characteristics expected in the completed Work.
 - 5. Corner pieces as follows:
 - a. Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
 - b. Miter joints for standing trim.
 - 6. Exposed cabinet hardware and accessories, one unit for each type and finish.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For architectural woodwork manufacturer and Installer.
- B. Product Certificates: For the following:
 - 1. Composite wood products.
 - 2. Thermoset decorative panels.

3. High-pressure decorative laminate.
4. Adhesives.
- C. Evaluation Reports: For preservative-treated and fire-retardant-treated wood materials, from ICC-ES.
- D. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates are not required, but the AWI Quality standards and program indicating that woodwork, including installation, complies with requirements of grades specified will be required to be met for this project.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For solid surface material and stone countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.8 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Shop that employs skilled workers who custom fabricate products like those required for this Project and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of products.
- C. The quality of standards of AWI will be required, but the AWI Certification of the fabricators is not required. Fabricator needs to know and understand the quality of standards of AWI.
- D. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
 1. Build mockup of typical countertop as shown on Drawings.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation.
 1. Protect materials from weather by covering with waterproof sheeting, securely anchored.
 2. Provide for air circulation around stacks and under coverings.
- B. Deliver interior finish carpentry materials only when environmental conditions comply with requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions comply with requirements specified for installation areas.
- C. Do not deliver cabinets until painting and similar operations that could damage woodwork have been completed in installation areas. If cabinets must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.
- D. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.
 1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
 2. Store stone on wood A-frames or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet-work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 25 and 55 percent during the remainder of the construction period.
- B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.
- C. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
 2. Verify dimensions of construction to receive stone countertops by field measurements before fabrication and indicate measurements on Shop Drawings.
- D. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.11 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that cabinets can be supported and installed as indicated.
- B. Coordinate locations of utilities that will penetrate countertops or backsplashes.

1.12 REFERENCE STANDARDS

- A. AWI/AWMAC/WI - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).

PART 2 PRODUCTS

2.1 MATERIALS, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of architectural wood cabinets indicated for construction, finishes, installation, and other requirements.
 1. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.
- B. [Certified Wood](#): Certify wood products as "FSC Pure" or "FSC Mixed Credit" in accordance with FSC STD-01-001 and FSC STD-40-004.

2.2 WOOD MATERIALS

- A. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.
- B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with applicable rules of any rules-writing agency certified by the American Lumber Standard Committee's (ALSC) Board of Review. Grade lumber by an agency certified by the ALSC's Board of Review to inspect and grade lumber under the rules indicated.
 1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. For exposed lumber, mark grade stamp on end or back of each piece.

- C. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
 - 1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches (75 mm) wide.
 - 2. Wood Moisture Content: 5 to 10 percent.
- D. Softwood Plywood: DOC PS 1, medium-density overlay.
- E. MDF: ANSI A208.2, Grade 130.
- F. Particleboard: ANSI A208.1, Grade M-2.
- G. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.
- H. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with 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.

2.3 INTERIOR TRIM

- A. Hardwood Lumber Trim for Transparent Finish (Stain or Clear Finish):
 - 1. Species and Grade: White Oak, NHLA (National Hardwood Lumber Association); Clear
 - 2. Cut: Rift cut
 - 3. Maximum Moisture Content: 10 percent.
 - 4. Finger Jointing: Not allowed.
 - 5. Gluing for Width: Not Allowed
 - 6. Veneered Material: Not allowed.
 - 7. Face Surface: Surfaced (smooth).
 - 8. Matching: Selected for compatible grain and color.
- B. Hardwood Lumber Trim for Opaque Finish:
 - 1. Wood Species: Any closed-grain hardwood, unless indicated otherwise.
 - 2. Maximum Moisture Content: 10 percent.

2.4 WOOD-VENEER PANELING

- A. Hardwood Veneer Plywood Paneling: Manufacturer's stock hardwood plywood panels complying with HPVA HP-1.
 - 1. Face Veneer Species and Cut: Rift-cut white oak.
 - 2. Veneer Matching: Selected for similar color and grain.
 - 3. Backing Veneer Species: Any hardwood compatible with face species.
 - 4. Construction: MDF core.
 - 5. Thickness: 3/4-inch.
 - 6. Panel Size: As indicated.
 - 7. Glue Bond: Type II (interior), containing no urea formaldehyde.
 - 8. Location: Wall finish type WF17.

2.5 WOOD-VENEER-FACED CABINETS

- A. Grade: Premium.
- B. Type of Construction: Frameless.
- C. Cabinet and Door and Drawer Front Interface Style: Flush overlay.
- D. Wood for Exposed Surfaces:

1. Wood Species and Cut for Exposed Surfaces: Clear or Grade A, White Oak; Rift Sawn.
2. Finish: Stained white with clear finish.
3. Grain Direction: Vertically for drawer fronts, doors, and fixed panels unless otherwise indicated.
4. Matching of Veneer Leaves: Slip match as selected by the Architect.
5. Veneer Matching within Panel Face: Balance match.
6. Edge banding: Hardwood matching panel face, 1/4" solid wood, species to match.
7. Semi-exposed Surfaces Other Than Drawer Bodies: Compatible species to that indicated for exposed surfaces, stained to match.
8. Edges of Thermoset Decorative Panel Shelves: PVC or polyester edge banding.
9. Drawer Subfronts, Backs, and Sides: Solid-hardwood lumber.
10. Drawer Bottoms: Hardwood plywood.
- E. Dust Panels: 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers unless located directly under tops.
- F. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
 1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

2.6 PLASTIC-LAMINATE-FACES CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of architectural plastic-laminate cabinets indicated for construction, finishes, installation, and other requirements.
 1. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.
- B. [Basis-of-Design Product](#): Subject to compliance with requirements, provide Formica Corporation, or comparable product by one of the following:
 1. Wilsonart International.
 2. Arborite.
- C. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 1. Type: MF5: equal to "Storm (912-58)," Matte by Formica.
- D. Grade: Premium.
- E. Type of Construction: Frameless.
- F. Cabinet, Door, and Drawer Front Interface Style: Flush overlay.
- G. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by woodwork quality standard.
- H. Laminate Cladding for Exposed Surfaces:
 1. Horizontal Surfaces: Grade HGS.
 2. Postformed Surfaces: Grade HGP.
 3. Vertical Surfaces: Grade VGS.
 4. Edges: Grade VGS.
 5. 3mm edge banding

6. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels Provide continuous match for wood grain laminates on doors and drawers of same cabinet.
- I. Materials for Semiexposed Surfaces:
 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.
 - a. Edges of Thermoset Decorative Panel Shelves: Polyester or PVC 3mm edge banding.
 - b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.
 2. Drawer Sides and Backs: Thermoset decorative panels with polyester or PVC 3 mm edge banding.
 3. Drawer Bottoms: Thermoset decorative panels.
- J. Dust Panels: 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers unless located directly under tops.
- K. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.
- L. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
 1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

2.7 SOLID-SURFACING MATERIAL

- A. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.
- B. [Basis-of-Design Product](#): Subject to compliance with requirements, provide Corian and Formica Corporation, or comparable product by one of the following:
 1. Wilsonart LLC.
 2. Avonite Surfaces.
 3. Colors and Patterns:
 - a. Type MF1: equal to "Luna Sand (757)" by Formica Corporation.
 - b. Type MF2: equal to "Artista Sage" by Corian.
 - c. Type MF3: equal to "Concrete" by Corian.
 - d. Type MF4: equal to "Carbon Concrete" by Corian.

2.8 TACKBOARD SURFACES

- A. Tackboard Surfaces: Uni-color linoleum resilient homogeneous tackable surface consisting of linseed oil, granulated cork, rosin binders and dry pigments calendared onto a natural burlap backing. Color shall extend through thickness of material.
 1. Basis of Design Product: Subject to compliance with requirements, provide "Forbo Bulletin Board," as manufactured by Forbo International, Humboldt Industrial Park, P.O. Box 667, Hazleton, PA 18201; Telephone: 800 842 7839, 570 459 0771; Fax: 570 450 0258. www.forboflooring.na.com.
 2. Fire Performance Characteristics: Comply with fire performance characteristics indicated below. Identify components with markings from testing and inspection organization.
 - a. ASTM E-84 (Fuel Contribution) – Class B
 - b. NFPA 225 (Critical Radiant Flux) – Class II
 4. Widths: 48 inch and 72 inch, as required by dimensions indicated in Drawings.
 5. Seams: V groove joints.
 6. Colors:

- a. WF15: "2206 Oyster Shell" by Forbo Bulletin Board.
- b. WF16: "2182 Potato Skin" by Forbo Bulletin Board.

2.9 CABINET HARDWARE AND ACCESSORIES

- A. Where close matching of cabinet hardware and door hardware is required, it may be preferable to specify cabinet hardware in Division 08.
- B. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)."
- C. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 170 degrees of opening, self-closing.
 - 1. Acceptable Manufacturers:
 - a. Blum.
 - b. Grass.
 - c. Häfele.
 - 2. Provide hinges as follows (based on maximum 24-inch wide doors):
 - a. 2 Hinges: For doors up to 35 inches high.
 - b. 3 Hinges: For doors 36 to 62 inches high.
 - c. 4 Hinges: For doors 63 to 78 inches high.
 - d. 5 Hinges: For doors 79 to 94 inches high.
- D. Cabinet Pulls: The following cabinet pulls are incorporated into the scope of the project and distinguished graphically in the Drawings:
 - 1. Pulls: top mounted, solid metal 6" long pull. Basis of Design: EPCO DP-41A
 - a. Finish: Satin Clear Anodized, unless noted otherwise.
- E. Catches: Magnetic catches, BHMA A156.9, B03041.
- F. Shelf Rests: 5-mm hole steel, nickel-plated. BHMA A156.9, B04013.
 - 1. Acceptable Manufacturers:
 - a. Häfele; 282.04.711
 - b. Knappe & Vogt; 332.
- G. Shelf Brackets and Standards, for closet and utility shelving:
 - 1. Vertical slotted shelf standards, BHMA A156.9, B04102
 - 2. Shelf brackets for slotted standards, BHMA A156.9, B04112.
- H. Drawer Slides: BHMA A156.9.
 - 1. Grade 1: Side mounted and extending under bottom edge of drawer; full-extension type; zinc-plated steel with polymer rollers.
 - 2. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-extension type; zinc-plated-steel ball-bearing slides.
 - 3. For drawers not more than 3 inches (75 mm) high and not more than 24 inches (600 mm) wide, provide Grade 1.
 - 4. For drawers more than 3 inches (75 mm) high but not more than 6 inches (150 mm) high and not more than 24 inches (600 mm) wide, provide Grade 1HD-100.
 - 5. For drawers more than 6 inches (150 mm) high or more than 24 inches (600 mm) wide, provide Grade 1HD-200.
 - 6. Acceptable Manufacturers:
 - a. Accuride.

- b. Blum.
 - c. Grass.
 - d. Häfele.
 - e. Knappe & Vogt.
- I. Door Locks: BHMA A156.11, E07121; provide at each cabinet door.
- J. Door and Drawer Silencers: Provide 3/8 inch to 1/2-inch diameter self-adhesive neoprene disks.
 - 1. Color: Clear.
- K. Countertop support brackets, Concealed:
 - 1. A&M Hardware EC(2.0) Concealed Countertop bracket. Recessed mount, size for countertop depth with upper extension.
 - a. Powder coated: 2 colors required, black and white – see drawings for locations.
- L. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
 - 1. Satin Stainless Steel: BHMA 630, unless noted otherwise.
- M. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.10 MISCELLANEOUS MATERIALS

- A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.
- B. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
- C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
- D. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.
 - 1. Verify adhesives have a VOC content of 30 g/L or less.
- E. Paneling Adhesive: Comply with paneling manufacturer's written instructions for adhesives.
 - 1. Verify adhesives have a VOC content of 50 g/L or less.
- F. Multipurpose Construction Adhesive: Formulation, complying with ASTM D3498, that is recommended for indicated use by adhesive manufacturer.
 - 1. Verify adhesives have a VOC content of 70 g/L or less.
- G. Sealant for Countertops: Manufacturer's standard sealant that complies with applicable requirements in Section 07 92 00 "Joint Sealants" and that will not stain the stone it is applied to.
 - 1. Joint Sealant: Single component, nonsag, neutral curing, silicone; Class 25 .
 - 2. Color: As selected by Architect from manufacturer's full range.
- H. Stone Joint Splines: Stainless-steel or brass washers approximately 1 inch in diameter and of thickness to fit snugly in saw-cut kerf in edge of stone units.
- I. Stone Cleaner: Specifically formulated for stone types, finishes, and applications indicated, as recommended by stone producer. Do not use cleaning compounds containing acids, caustics, harsh fillers, or abrasives.
- J. Stone Sealer: Colorless, stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application indicated.

2.11 FABRICATION

- A. Ease edges of lumber less than 1 inch (25 mm) in nominal thickness to 1/16-inch (1.5-mm) radius and edges of lumber 1 inch (25 mm) or more in nominal thickness to 1/8-inch (3-mm) radius.
- B. Interior Woodwork Grade: Unless otherwise indicated, provide Premium-grade interior woodwork complying with referenced quality standard.
- C. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- D. Fabricate cabinets to dimensions, profiles, and details indicated.
- E. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.
- F. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

2.12 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH FABRICATION

- A. For trim items wider than available lumber, use veneered construction. Do not glue for width.
- B. For rails wider or thicker than available lumber, use veneered construction. Do not glue for width or thickness.
- C. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.
- D. Assemble casings in plant except where limitations of access to place of installation require field assembly.
- E. Assemble moldings in plant to maximum extent possible. Miter corners in plant and prepare for field assembly with bolted fittings designed to pull connections together.

2.13 INTERIOR STANDING AND RUNNING TRIM FOR OPAQUE FINISH FABRICATION

- A. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.
- B. Assemble casings in plant except where limitations of access to place of installation require field assembly.
- C. Assemble moldings in plant to maximum extent possible. Miter corners in plant and prepare for field assembly with bolted fittings designed to pull connections together.

2.14 SOLID-SURFACING-MATERIAL COUNTERS FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 - 1. Grade: Premium.
- B. Countertops: 2-cm- thick, solid surface material laminated to 3/4-inch- thick plywood with edges built up with 2-cm- thick, solid surface material.
- C. Backsplashes: 3/4 inch-thick, solid surface material.
- D. Fabricate tops with shop-applied edges unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate with loose backsplashes for field assembly.

2. Install integral sink bowls in countertops in the shop.
- E. Joints:
 1. Fabricate countertops without joints.
 2. Fabricate countertops in sections for joining in field.
 - a. Joint Locations: Not within 18 inches of a sink and not where a countertop section less than 36 inches long would result, unless unavoidable.
 - b. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints. Make width of cuts slightly more than thickness of splines to provide snug fit.
- F. Cutouts and Holes:
 1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.
 - b. Provide vertical edges, rounded to 3/8-inch radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch into fixture opening.
 - c. Provide 3/4-inch full bullnose edges projecting 3/8 inch into fixture opening.
 2. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

2.15 TACKBOARD SURFACES FABRICATION

- A. Install tackboard surfaces to wall surfaces and architectural woodwork substrates indicated in the Drawings, according to the tackboard surface manufacturer's instructions.
- B. Allow substrate and tackboard surface to acclimate to occupancy temperatures and humidity for 72 hours prior to lamination or fabrication.
- C. Conduct an adhesion material bond test prior to fabrication.
- D. Apply tackboard surface manufacturer's recommended adhesive according to instructions with recommended applicators. Apply tackboard surface to substrate and roll, cold press or hot press thoroughly.
- E. Install tackboard surfaces in a manner that will not strip or harm the factory finish of the tackboard surface.
- F. Install V groove seams unless otherwise indicated for tackboard surfaces. Follow manufacturer's recommendations for seaming.
- G. Fabricate tackboard panels with edge treatment indicated in Drawings.
- H. Follow tackboard surface manufacturer's recommendations for cleaning, allowing the recommended duration after installation onto substrate to achieve an adequate bond and cure before conducting wet cleaning procedures.
- I. Hang tackboard panels according to attachment indicated in the Drawings.

2.16 SHOP FINISHING

- A. Grade: Provide finishes of same grades as items to be finished.
- B. General: Finish interior carpentry at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
- C. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.

1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require backpriming when surfaced with plastic laminate, backing paper, or thermoset decorative panels.
- D. Shop Priming: Shop apply the prime coat including backpriming, if any, for items specified to be field finished. Refer to Division 09 painting Sections for material and application requirements.
- E. Transparent Finish:
 1. Grade: Premium.
 2. AWI Finish System: 12, water-based polyurethane.
 3. Staining: White wash to match Architect's sample.
 4. Wash Coat for Stain Finish: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
 5. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
 6. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523.

END OF SECTION 06 40 23

SECTION 07 11 13
BITUMINOUS DAMPPROOFING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Dampproofing. **For use below grade only.**
- B. Protection boards.

1.2 RELATED REQUIREMENTS

- A. Section 07 21 00 - Thermal Insulation: Rigid insulation board used as protection board.
- B. Single source supplier must supply compatible products under all related sections below or provide compatibility testing for materials that connect to or come in contact with the product being provided:
 - 1. Division 07 Section "Bituminous dampproofing."
 - 2. Division 07 Section "Cold-Fluid-Applied Waterproofing"
 - 3. Division 07 Section "Fluid-Applied Membrane Air Barriers"
 - 4. Division 07 Section "Joint Sealants" for joint-sealant materials and installation.
 - 5. Division 07 Section "thermal Insulation" for below-grade insulation.
 - 6. Division 08 Section "Glazed Aluminum Curtain Walls for extruded silicone air and vapor barrier transitions.

1.3 REFERENCE STANDARDS

- A. ASTM C272/C272M - Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions; 2018.
- B. ASTM D41/D41M - Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing; 2011 (Reapproved 2023).
- C. ASTM D1227/D1227M - Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing; 2013, with Editorial Revision (2019).
- D. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2016 (Reapproved 2023).
- E. ASTM D1668/D1668M - Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing; 1997a (Reapproved 2021).
- F. NRCA (WM) - The NRCA Waterproofing Manual; 2021.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide properties of primer, membrane, and mastics.
- C. Product Certificates: For dampproofing, certifying compatibility of dampproofing materials with Project materials that connect to or that come in contact with the barrier; signed by the product manufacturer. Or provide compatibility testing for materials that connect to or come in contact with the product being provided. The list of products requiring compatibility includes but is not limited to:
 - 1. Cold Fluid-Applied Waterproofing.
 - 2. Fluid-applied membrane air barriers, transition strips, flashings and sealants.
 - 3. Joint Sealants
 - 4. Thermal insulation

1.5 QUALITY ASSURANCE

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

1.6 FIELD CONDITIONS

- A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application until dampproofing has cured.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Source Limitations: Obtain primary dampproofing materials and primers from a single source from a single manufacturer. Provide protection course drainage panels and auxiliary materials recommended in writing by the manufacturer of primary materials.
- C. Single source supplier must supply compatible products under all related sections below:
 - 1. Section 07 11 13 - Bituminous Dampproofing.
 - 2. Section 07 14 16 - Fluid-Applied Waterproofing.
 - 3. Section 07 27 26 - Fluid-Applied Membrane Air Barriers.
 - 4. Section 07 92 00 - Joint Sealants
 - 5. Section 08 44 13 - Glazed Aluminum Curtain Walls for extruded silicone air and vapor barrier transitions.
- D. Bituminous Dampproofing Manufacturers:
 - 1. Carlisle Coatings & Waterproofing, Inc: www.carlisleccw.com/#ste.
 - 2. Henry Company: www.henry.com/#ste.
 - 3. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#ste.
 - 4. W. R. Meadows, Inc: www.wrmeadows.com/#sle.

2.2 BITUMINOUS DAMPPROOFING

- A. Bituminous Dampproofing: Cold-applied water-based emulsion; asphalt with mineral colloid or chemical emulsifying agent; with or without fiber reinforcement; asbestos-free; suitable for application on vertical and horizontal surfaces.
 - 1. VOC Content: Not more than permitted by local, State, and federal regulations.
 - 2. Applied Thickness: Per manufacturer's requirements.

2.3 BITUMEN MATERIALS

- A. Cold Asphaltic Type:
 - 1. Emulsified Asphalt: ASTM D1227/D1227M, with fiber reinforcement other than asbestos, Type II, Class 1 or 2.
 - 2. Asphalt Primer: ASTM D41/D41M, compatible with substrate.

2.4 ACCESSORIES

- A. Protection Board: Rigid insulation; see Section 07 21 00.

2.5 AUXILIARY MATERIALS

- A. Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.
- B. Emulsified-Asphalt Primer: ASTM D1227/D1227M, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.
- C. Asphalt-Coated Glass Fabric: ASTM D1668/D1668M, Type I.
- D. Patching Compound: Epoxy or latex-modified repair mortar of type recommended in writing by dampproofing manufacturer.
- E. Fan folded, with a core of extruded-polystyrene board insulation faced on one side with plastic film, nominal thickness 1/4 inch, with a compressive strength of not less than 8 psi per ASTM D1621, and maximum water absorption by volume of 0.6 percent per ASTM C272/C272M.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions are acceptable prior to starting this work.
- B. Verify substrate surfaces are durable, free of matter detrimental to adhesion or application of dampproofing system.
- C. Verify that items penetrating surfaces to receive dampproofing are securely installed.

3.2 PREPARATION

- A. Protect adjacent surfaces not designated to receive dampproofing.
- B. Clean and prepare surfaces to receive dampproofing in accordance with manufacturer's instructions.
- C. Do not apply dampproofing to surfaces unacceptable to manufacturer.
- D. Apply mastic to seal penetrations, small cracks, or minor honeycombs in substrate.

3.3 APPLICATION

- A. Concrete Foundations and Parged Masonry Foundation Walls: Apply primer and two coats at not less than 1.5 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat, or, one trowel coat at not less than 4 gal./100 sq. ft..
 - 1. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.
- B. Steel Columns that extend below grade: Apply primer and two brush or spray coats at not less than 1.5 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat primer and one fibered brush or spray coat at not less than 3 gal./100 sq. ft. or primer and one trowel coat at not less than 5 gal./100 sq. ft..
- C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft..
- D. Concrete Backup for Brick Veneer Assemblies: Apply one brush or spray coat at not less than 1 gal./100 sq. ft..
- E. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches over outside face of footing.
 - 1. Extend dampproofing 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
 - 2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where indicated as "reinforced," by embedding an 8-inch- wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

- F. Where dampproofing exterior face of inner wythe of exterior masonry cavity walls, lap dampproofing at least 1/4 inch onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.
 - 1. Extend dampproofing over outer face of structural members and concrete slabs that interrupt inner wythe.
 - 2. Lap dampproofing at least 1/4 inch onto shelf angles supporting veneer.
- G. Where dampproofing interior face of above-grade, exterior concrete, and masonry walls, continue dampproofing through intersecting walls by keeping vertical mortar joints at intersection temporarily open or by dampproofing wall before constructing intersecting walls.
- H. Perform this work in accordance with manufacturer's instructions and NRCA (WM) applicable requirements.
- I. Prime surfaces in accordance with manufacturer's instructions and NRCA (WM) applicable requirements.

END OF SECTION 07 11 13

SECTION 07 14 00
FLUID-APPLIED WATERPROOFING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Water-based asphalt emulsion waterproofing.

1.2 RELATED REQUIREMENTS

- A. Section 07 21 00 - Thermal Insulation: Insulation used for protective cover.
- B. Single source supplier must supply compatible products under all related sections below or provide compatibility testing for materials that connect to or come in contact with the product being provided:
 - 1. Division 07 Section "Bituminous dampproofing."
 - 2. Division 07 Section "Cold-Fluid-Applied Waterproofing"
 - 3. Division 07 Section "Fluid-Applied Membrane Air Barriers"
 - 4. Division 07 Section "Joint Sealants" for joint-sealant materials and installation.
 - 5. Division 07 Section "Thermal Insulation" for below-grade insulation.
 - 6. Division 08 Section "Glazed Aluminum Curtain Walls for extruded silicone air and vapor barrier transitions.

1.3 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.
- B. ASTM C836/C836M - Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course; 2018 (Reapproved 2022).
- C. ASTM C898/C898M - Standard Guide for Use of High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane with Separate Wearing Course; 2017.
- D. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016 (Reapproved 2023).
- E. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension; 2016 (Reapproved 2021).
- F. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2016 (Reapproved 2023).
- G. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating; 2023.
- H. ASTM D4259 - Standard Practice for Preparation of Concrete by Abrasion Prior to Coating Application; 2018.
- I. ASTM D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method; 1983 (Reapproved 2018).
- J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2023.
- K. NRCA (WM) - The NRCA Waterproofing Manual; 2021.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for membrane, surface conditioner, flexible flashings, joint cover sheet, and joint and crack sealants.
- C. Shop Drawings:

1. Show locations and extent of waterproofing.
2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
3. Indicate special joint or termination conditions and conditions of interface with other materials.
- D. Product Certificates: For cold-fluid-applied waterproofing, certifying compatibility of waterproofing materials with Project materials that connect to or that come in contact with the barrier; signed by the product manufacturer. Or provide compatibility testing for materials that connect to or come in contact with product being provided. The list of products requiring compatibility includes but is not limited to:
 1. Bituminous Dampproofing.
 2. Fluid-applied membrane air barriers, transition strips, flashings and sealants.
 3. Joint Sealants.
 4. Thermal insulation.
- E. Warranty Documentation:
 1. Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
 2. Submit installer's documentation that installation complies with warranty conditions for the field-applied waterproofing.

1.5 QUALITY ASSURANCE

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

1.6 MOCK-UPS

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Construct mock-up consisting of 100 sq ft of horizontal and vertical fluid-applied waterproofing; to represent finished work including internal and external corners, control joints, expansion joints, and counterflashings.
- C. After acceptance by Architect for standard of quality, Mock-up may remain as part of work.

1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until cured.
- B. Do not apply waterproofing to a damp or wet substrate, when relative humidity exceeds 85 percent, or when temperatures are less than **5 degrees F** above dew point.
- C. Do not apply waterproofing in snow, rain, fog or mist, or when such weather conditions are imminent during application and curing period.

1.8 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer's Special Warranty: Provide **10-year** warranty for waterproofing failing to resist penetration of water commencing on Date of Substantial Completion. Complete forms in Owner's name.
- C. Installer Warranty: Provide 2-year warranty for waterproofing failing to resist penetration of water commencing on Date of Substantial Completion. Complete forms in Owner's name and register with installer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitation for Waterproofing and Fluid-Applied Membrane Air Barriers: Obtain waterproofing and Fluid-Applied Membrane Air Barriers Barriers from the same manufacturer.
- B. Water-Based Asphalt Emulsion Waterproofing:
 - 1. Basis-of-Design Product: Provide Tremco Commercial Sealants & Waterproofing; TREMproof 260: www.tremcosealants.com/#sle or comparable product approved by the Architect by one of the following:
 - a. Carlisle Coatings & Waterproofing, Inc: www.carlisleccw.com/#ste.
 - b. W. R. Meadows, Inc: www.wrmeadows.com/#sle.
 - c. Henry Company: www.henry.com/#ste.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 FLUID-APPLIED WATERPROOFING MATERIALS

- A. Water-Based Asphalt Emulsion Waterproofing: Cold Fluid-Applied Waterproofing: polymer-enhanced, single component, fluid-applied, asphalt emulsion, below-grade waterproofing membrane.
 - 1. Cured Thickness: 60 mil, 0.060 inch, minimum.
 - 2. Suitable for installation over concrete substrates.
 - 3. Elongation: 800 percent, minimum, measured in accordance with ASTM D412.
 - 4. VOC Content: No more than 72 g/L
 - 5. Hardness, ASTM D 2240: 50 minimum; Pass.
 - 6. Low Temperature Crack Bridging, ASTM C836; Modified ASTM C1305: Pass.
 - 7. Adhesion-in-Peel after Water Immersion, ASTM C836; ASTM C794: Exceeds.
 - 8. Peel adhesion, ASTM D903: Passes
 - 9. Low-Temp Flexibility, ASTM C836: Pass.
 - 10. Water resistance, ASTM C836, AATC-127: Pass
 - 11. Water Vapor Permeance E96 Dry Cup: 0.028 US Perms
 - 12. Water Vapor Permeance E96 Wet Cup: 0.032 US Perms
 - 13. Stability (80°F/26.7°C): 6 months Minimum 1 year
 - 14. Solids 64%, Density 8.1 lb/gal
 - 15. Water Vapor Permeability: 0.02 perm, maximum, measured in accordance with ASTM E96/E96M.
 - 16. Basis-of-Design Products:
 - a. Tremco Commercial Sealants & Waterproofing; TREMproof 260: www.tremcosealants.com/#sle.

2.3 ACCESSORIES

- A. General: Accessory materials as described in manufacturer's written installation instructions, recommended to produce complete waterproofing system meeting performance requirements, and compatible with waterproofing material and adjacent materials.
- B. Surface Primer, Sealer, or Surface Conditioner: Manufacturer's standard type, compatible with membrane compound; as recommended by membrane manufacturer.
- C. Sealant for Joints and Cracks in Substrate: Type compatible with waterproofing material and as recommended by waterproofing manufacturer.
- D. Protection Mat: Polyester mat at least 14 oz/sq yd to protect vertical or horizontal waterproofing membranes.

1. Thickness: 100 mil, 0.10 inch, minimum.
2. Width: 40 inches.
- E. Drainage Panel: Drainage layer with geotextile filter fabric on earth side.
 1. Composition: Dimpled polyethylene, polypropylene, or polystyrene core; polypropylene or polyester filter fabric.
 2. Thickness: As indicated on drawings.
 3. Core Compressive Strength: 15,000 psf, minimum, in accordance with ASTM D1621

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
- C. Verify substrate surfaces are free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of waterproofing system.
- D. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.
- E. Verify that substrate surfaces are smooth, free of honeycomb or pitting, and not detrimental to full contact bond of waterproofing materials.
- F. Verify that items penetrating surfaces to receive waterproofing are securely installed.
- G. Where existing conditions are responsibility of another installer, notify Architect of unsatisfactory conditions.
- H. Do not proceed with this work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect adjacent surfaces from damage not designated to receive waterproofing.
- B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions.
 1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate in accordance with ASTM D4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces in accordance with ASTM D4258.
- C. Do not apply waterproofing to surfaces unacceptable to waterproofing manufacturer.
- D. Fill non-moving joints and cracks with a filler compatible with waterproofing materials.
- E. Prepare, treat, rout, and fill joints and cracks in substrate in accordance with waterproofing manufacturer's written instructions and to recommendations in ASTM C898/C898M. Before coating surfaces, remove dust and dirt from joints and cracks in accordance with ASTM D4258.
 1. Comply with ASTM C1193 for joint-sealant installation.
 2. Apply bond breaker on sealant surface, beneath preparation strip.
 3. Prime substrate along each side of joint and apply a single thickness of preparation strip at least 6 inches wide along each side of joint. Apply waterproofing in two separate applications and embed a joint reinforcing strip in the first preparation coat.
- F. Install sheet flashing and bond to deck and wall substrates where required in accordance with waterproofing manufacturer's written instructions.
 1. Extend sheet flashings for 4 inches onto perpendicular surfaces and items penetrating substrate.

- G. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners in accordance with waterproofing manufacturer's written instructions and to recommendations in ASTM C898/C898M.
 - 1. Apply waterproofing in two separate applications and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.
- H. Install cant strips at inside corners.

3.3 INSTALLATION

- A. Install waterproofing to specified minimum thickness in accordance with manufacturers instructions, NRCA (WM), and ASTM C898/C898M applicable requirements.
- B. Apply primer or surface conditioner at a rate recommended by manufacturer, and protect conditioner from rain or frost until dry.
- C. Start installing waterproofing in presence of manufacturer's technical representative.
- D. Apply primer over prepared substrate unless otherwise instructed in writing by waterproofing manufacturer.
- E. Unreinforced Waterproofing Applications: Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.
 - 1. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases and pinholes, with a dry film thickness of 60 mils.
 - 2. Apply waterproofing to prepared wall terminations and vertical surfaces.
 - 3. Verify manufacturer's recommended wet film thickness of waterproofing every 100 sq. ft..
- F. Cure waterproofing, taking care to prevent contamination and damage during application and curing.
- G. Install protection course with butted joints over waterproofing before starting subsequent construction operations.
 - 1. For horizontal applications, install protection course loose laid over fully cured membrane.
 - 2. For vertical applications, set protection course in nominally cured membrane, which will act as an adhesive. If membrane cures before application of protection course, use adhesive.
 - 3. Thermal insulation specified in Section 07 21 00 - Thermal Insulation may be used in place of a separate protection course for vertical applications when approved in writing by waterproofing manufacturer.

3.4 INSTALLATION - DRAINAGE PANEL AND PROTECTION BOARD

- A. Place drainage panel directly against membrane, butt joints, place to encourage drainage downward, and scribe and cut boards around projections, penetrations, and interruptions.

3.5 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Testing Agency: Engage a qualified testing agency to inspect substrate conditions, surface preparation, waterproofing application, protection, and drainage components, and to furnish reports to Architect.
- C. Owner will provide testing and inspection services, and Contractor to provide temporary construction and materials for testing.
- D. Waterproofing will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Provide daily on-site attendance of waterproofing and insulation manufacturer's representative during installation of this work.

3.6 PROTECTION

- A. Protect waterproofing from damage and wear during remainder of construction period.
- B. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

END OF SECTION 07 14 00

SECTION 07 21 00
THERMAL INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Board insulation at cavity wall construction, perimeter foundation wall, underside of floor slabs, over roof sheathing, and rainscreen wall construction.
- B. Batt insulation and vapor retarder in exterior wall, ceiling, and roof construction.
- C. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.
- D. Insulating coating.

1.2 RELATED REQUIREMENTS

- A. Section 07 54 00 - Thermoplastic Membrane Roofing: Installation requirements for board insulation over low slope roof deck.

1.3 DEFINITIONS

- A. Mineral Fiber Material Composition: Insulation referred to as mineral fiber block, board, and blanket insulation is composed of fibers from mineral based substances such as rock, slag, or glass and processed from the molten state into fibrous form.
 - 1. Based on type of insulation substance, the material will be referred to as a mineral fiber when having a rock or slag base, and glass fiber with a glass or silica sand base, also considered a mineral.
 - 2. Insulation blankets are flexible units consisting of felted, bonded, or unbonded fibers formed into rolls or flat cut pieces referred to as batts; rolls are simply longer versions of batts.
 - 3. For additional information about mineral fiber and the various classification types, refer to the following reference standards; ASTM C553, ASTM C612, ASTM C665, and ASTM C726.

1.4 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).
- C. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2023.
- D. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).
- E. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.
- F. ASTM C726 - Standard Specification for Mineral Wool Roof Insulation Board; 2017.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
 - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
 - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

1.7 FIELD CONDITIONS

- A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 PRODUCTS

2.1 APPLICATIONS

- A. Insulation Under Concrete Slabs: Extruded polystyrene (XPS) board.
- B. Insulation at Perimeter of Foundation: Extruded polystyrene (XPS) board.
- C. Insulation Inside Masonry Cavity Walls and Rainscreen Assemblies: Mineral fiber board.
- D. Insulation in Metal Framed Ceiling Structure: Batt insulation with integral vapor retarder.
- E. Insulation over Roof Deck: Polyisocyanurate board.

2.2 FOAM BOARD INSULATION MATERIALS

- A. Extruded Polystyrene (XPS) Board Insulation (At perimeter horizontal insulation locations under slab and At perimeter vertical insulation locations at slab edge and foundations): Comply with ASTM C578 with either natural skin or cut cell surfaces.
 - 1. Type and Compressive Resistance: Type VI, 40 psi (276 kPa), minimum.
 - 2. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
 - 3. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
 - 4. Type and Thermal Resistance, R-value: Type VI, 5.0 (0.88), minimum, per 1 inch thickness at 75 degrees F mean temperature.
 - 5. Thickness: 2" unless otherwise noted.

2.3 MINERAL FIBER BOARD INSULATION MATERIALS

- A. Mineral Wool Block, Board, or Blanket Thermal Insulation: Complying with ASTM C612 or ASTM C553.
 - 1. Where indicated, provide fiberglass reinforced polypropylene facing on one side; with flame spread index of 25 or less, when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.
 - 3. Board Thickness: 2-1/2 inches unless noted otherwise.
 - 4. Thermal Resistance: R-value of 4.3 per inch at 75 degrees F, minimum, when tested in accordance with ASTM C518.
 - 5. Maximum Density: 8 pcf, nominal.
 - 6. Fungi resistance: Zero mold growth to ASTM C1338.
 - 7. Products:

- a. Johns Manville; CladStone 80 Water & Fire Block Insulation: www.jm.com/#sle.
- b. ROCKWOOL; CURTAINROCK 80: www.rockwool.com/#sle.
- c. Thermafiber, Inc; RainBarrier Dark: www.thermafiber.com/#sle.
- d. Thermafiber, Inc; Safing: www.thermafiber.com/#sle.
- e. Substitutions: See Section 01 60 00 - Product Requirements.

2.4 INSULATING COATING MATERIALS

- A. Acrylic Insulating Coating: Fluid-applied, acrylic insulating coating that when applied to various substrates provides thermal protection and corrosion resistance.
 1. Substrate: As indicated on drawings.
 2. Primer: As recommended by coating manufacturer for applied substrate.
 3. Number of Coatings: Two.
 4. Dry Film Thickness (DFT): 30 to 40 mil, 0.030 to 0.040 inch, minimum, per coat.
 5. Surface Burning Characteristics: Smoke developed index of 450 or less, and flame spread index of 25 or less, Class A, when tested in accordance with ASTM E84.
 6. Temperature Resistance, Fully Cured: At least 325 degrees F in coordination with type of substrate and primer being used.
 7. Basis-of-Design Products:
 - a. Tnemec Company, Inc; Series 971 Aerolon Acrylic: www.tnemec.com/#sle.

2.5 ACCESSORIES

- A. Adhesive: Type recommended by insulation manufacturer for application.
 1. Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
- B. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AGM Industries, Inc; www.amgindustries.com
 - b. Gemco; www.okgemco.com
 2. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation and adhesive.
- B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.2 BOARD INSTALLATION AT FOUNDATION PERIMETER

- A. A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install boards in an orientation as recommended by manufacturer on foundation perimeter.
 1. Butt edges and ends tightly to adjacent boards and to protrusions.

- C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.
- D. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
 - 1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions.
 - 2. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.
 - 3. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings between concrete substrate and insulation.
 - 4. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.
 - 5. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

3.3 BOARD INSTALLATION AT CAVITY WALLS

- A. Install boards to fit snugly between wall ties.
- B. Install boards horizontally on walls.
- C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.4 BOARD INSTALLATION UNDER CONCRETE SLABS

- A. Place insulation under slabs on grade after base for slab has been compacted.
- B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.
- C. Prevent insulation from being displaced or damaged while placing vapor retarder and placing slab.

3.5 BATT INSTALLATION

- A. Install insulation and vapor retarder in accordance with manufacturer's instructions.
- B. Install in exterior roof spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

3.6 FIELD QUALITY CONTROL

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

3.7 PROTECTION

- A. Do not permit installed insulation to be damaged prior to its concealment.

3.8

END OF SECTION 07 21 00

SECTION 07 27 26
FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fluid-applied membrane high-build air barriers, vapor permeable.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete substrate.
- B. Section 04 20 00 - Unit Masonry: Concrete masonry.
- C. Section 06 10 00 - Rough Carpentry: Exterior sheathing.
- D. Section 07 92 00 - Joint Sealants: Sealants applied to adjacent work.
- E. Single source supplier must supply compatible products under all related sections below or provide compatibility testing for materials that connect to or come in contact with the product being provided:
 - 1. Division 07 Section "Bituminous dampproofing."
 - 2. Division 07 Section "Cold-Fluid-Applied Waterproofing"
 - 3. Division 07 Section "Fluid-Applied Membrane Air Barriers"
 - 4. Division 07 Section "Joint Sealants" for joint-sealant materials and installation.
 - 5. Division 07 Section "Thermal Insulation" for insulation.
 - 6. Division 08 Section "Glazed Aluminum Curtain Walls for extruded silicone air and vapor barrier transitions."

1.3 DEFINITIONS

- A. Air Barrier: Airtight barrier made of material that provides a **continuous** barrier that is relatively air impermeable but water vapor permeable, both to the degree specified, with sealed seams and with sealed joints to adjacent surfaces.
- B. Air-Barrier Accessory: A transitional component of the air barrier that provides **continuity**.
- C. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.4 REFERENCE STANDARDS

- A. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- B. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension; 2016 (Reapproved 2021).
- C. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection; 2021.
- D. ASTM D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method; 1983 (Reapproved 2018).
- E. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers; 2022.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- G. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2023.
- H. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.

- I. ASTM E2357 - Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies; 2024.
- J. ASTM G154 - Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials; 2023.
- K. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2023.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on material characteristics, performance criteria, and limitations.
- C. Shop Drawings: Provide drawings of special joint conditions.
- D. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
 - 1. Include details of interfaces with other materials that form part of air barrier.
- E. Installer's qualification statement.
- F. Warranty Documentation: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and are registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience and approved by manufacturer.
 - 1. **Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.**

1.7 MOCK-UPS

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Provide mock-up of air barrier assembly, 100 square feet, indicating interface with adjacent construction, other termination conditions, as well as application and execution details.
 - 1. Apply air barrier assembly to mock-up components, including wall substrates, window and door frames and sills, insulation, flashing, corner conditions, junctions with roof system and foundation wall, and typical penetrations and gaps, indicating material interface details and seals.
- C. After acceptance by Architect for standard of quality, Mock-up may remain as part of work.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to project site in original packaging with seals unbroken and properly labeled.
- B. Store materials in their original undamaged packaging within clean, dry, and protected location at a temperature less than 90 degrees F.
 - 1. Protect stored materials from direct sunlight.

1.9 FIELD CONDITIONS

- A. Maintain temperature and humidity recommended by materials manufacturer before, during, and after installation.
 - 1. Do not apply air barrier products when air or substrate temperatures are above 100 degrees F or below 20 degrees F.
 - 2. Allow wet substrates to dry prior to applying air barrier products.

1.10 WARRANTY

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

- B. Warranty: Include coverage to repair or replace air barrier coatings and accessory products that demonstrate deterioration or failure within a 10-year period after Date of Substantial Completion due to material failure under normal use; failure includes water or air penetration through air barrier assembly.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Single source supplier must supply compatible products under all related sections below:
1. Section 07 11 13 - Bituminous Dampproofing.
 2. Section 07 14 16 - Fluid-Applied Waterproofing.
 3. Section 07 27 26 - Fluid-Applied Membrane Air Barriers.
 4. Section 07 92 00 - Joint Sealants
 5. Section 08 44 13 - Glazed Aluminum Curtain Walls for extruded silicone air and vapor barrier transitions.
- B. Fluid-Applied Membrane Air Barrier:
1. Basis-of-Design Product: Provide ExoAir 230 as manufactured by Tremco Inc., or a comparable product approved by the Architect by one of the following:
 - a. Carlisle Coatings & Waterproofing, Inc: www.carlisleccw.com/#ste.
 - b. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#ste.
 - c. W. R. Meadows, Inc: www.wrmeadows.com/#sle.

2.2 FLUID-APPLIED MEMBRANE AIR BARRIER ASSEMBLY

- A. Applications:
1. Concrete Walls:
 - a. See Section 03 30 00 for concrete.
 2. Concrete Masonry Walls:
 - a. See Section 04 20 00 for concrete masonry.
 3. Exterior Sheathing on Steel Stud Walls:
 - a. See Section 06 10 00 for exterior sheathing.
 - b. See Section 07 92 00 for joint sealants applied to adjacent work.
- B. Fluid-Applied, Vapor-Permeable Membrane Air Barrier: Elastomeric, UV-resistant, synthetic membrane, formulated for application in a range of 48 - 70 mils (wet), 25 - 35 mils (dry)
1. Dry Film Thickness (DFT): 25 mils, 0.025 inch, minimum for exterior sheathing and 35 mils minimum for porous substrates, but not less than manufacturer's requirements.
 2. Air Permeance: 0.004 cfm/sq ft maximum leakage when tested at 1.57 psf pressure difference in accordance with ASTM E2178.
 3. Vapor Permeance: 12 perms, minimum, when tested in accordance with ASTM E96/E96M using Desiccant Method at 73.4 degrees F.
 4. Air Barrier Leakage: Not greater than 0.04 cfm/sq ft of surface area at pressure of 1.57 psf when tested in accordance with ASTM E2357.
 5. Ultraviolet (UV) Exposure: Rated for up to 5,000 hours of exposure in accordance with ASTM G154; not less than 12 months.
 6. Elongation: Greater than 600 percent, when tested in accordance with ASTM D412.

7. Surface Burning Characteristics: Class A, Flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.
8. Fire Propagation Characteristics: Provide air barrier coatings and accessory materials that are tested for compliance with NFPA 285 when used within exterior wall assembly.
9. Nail Sealability: Pass head of water test in accordance with ASTM D1970/D1970M.
10. Basis-of-Design Products: Tremco, Inc., ExoAir 230.

2.3 ACCESSORIES

- A. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.
- B. Thinners and Cleaners: As recommended by material manufacturer.
- C. Crack Fillers: Provide substrate manufacturer's recommended crack fillers or sealants compatible with air barrier assembly components and adjacent materials.
- D. Block Filler: Provide air barrier coating manufacturer's recommended latex block filler compatible with substrate and adjacent materials.
- E. Primer: Liquid primer meeting VOC limitations, recommended for substrate by membrane air barrier manufacturer, when installing modified bituminous self-adhered membranes.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces and conditions are ready to accept work of this section.
- B. Verify that surfaces are clean, dry, and free of frost, dust, dirt, grease, oil, curing compounds, form release agents, laitance, efflorescence, mildew, excess alkalinity, and other conditions affecting performance of this work.
- C. Verify that new concrete and mortar to receive coating application has cured in accordance with substrate and air barrier coating manufacturer's instructions.
- D. Preinstallation Testing: Prior to application of air barrier coatings, perform following tests to verify condition of substrate in accordance with manufacturer's instructions.
 1. Adhesion: Perform field adhesion tests in accordance with ASTM D4541 to determine if primer is required to adhere air barrier coatings to substrates.
 2. Alkalinity: Verify substrate is within alkalinity range acceptable to manufacturer.
 3. Moisture Level: Verify substrate moisture content is acceptable to manufacturer, and substrate is visibly dry and free of moisture.
 - a. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.
- E. Proceed with work once conditions comply with air barrier coating manufacturer's recommendations.

3.2 PREPARATION

- A. Protect work of other trades against damage from application of air barrier coatings.
- B. Protect adjacent surfaces not designated to receive air barrier coatings; provide protection for pedestrians, vehicles, landscaping, and surrounding areas to prevent contact with coating materials.

- C. Clean substrates to remove contaminants and foreign material by pressure cleaning, wire brushing, grinding or other method recommended by air barrier coatings manufacturer.
- D. Prepare substrates in accordance with air barrier coating manufacturer's written instructions.
- E. Repair deteriorated or damaged substrates, repair masonry joints, and fill cracks, voids, honeycombs, and other defects using materials as recommended by air barrier coating manufacturer, and allow patching materials to fully cure.
 - 1. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.
 - 2. Fill cracks larger than 1/16 inch wide using applicable joint sealant, and fill cracks larger than 1 inch wide using joint sealant and compatible bond breaker where movement is expected.
- F. Primer: Apply primer to substrates where required based upon preinstallation testing and air barrier coating manufacturer's recommendations, using application methods and rate of application recommended by manufacturer; allow primer to fully dry prior to application of air barrier coating.
 - 1. Apply block filler as primer on concrete masonry unit (CMU) substrates where required to fill pores and provide smooth application of air barrier coating.

3.3 INSTALLATION OF ACCESSORIES

- A. General: Install strips, transition strips, and accessory materials according to air-barrier manufacturer's written instructions. Install transition materials and other accessories to form connect and seal membrane air barrier material to adjacent components of building air barrier system, including, but not limited to, roofing system air barrier, exterior fenestration systems, door framing, and other openings.
- B. Primer: Apply primer to substrates when recommended by air barrier manufacturer at required rate for those substrates that will be receiving a modified bituminous self-adhered membrane. Reprime areas not covered within 24 hours.
- C. Assembly Transitions: Connect and seal exterior wall air barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
 - 1. Opening Transitions: Fill gaps at perimeter of openings with foam sealant and apply approved transition or accessory material
 - 2. Penetrations: Fill gaps at perimeter of penetrations with foam sealant and level with approved sealant. or seal transition strips around penetrating objects and terminate with approved sealant.
 - 3. Joints: Bridge and cover isolation joints, expansion joints, and discontinuous joints between separate assemblies utilizing approved transition or accessory materials.
 - 4. Changes in Plane: Apply approved sealant beads at corners and edges to form smooth transition.
 - 5. Substrate Gaps: Cover gaps with stainless steel sheet mechanically attached to substrate and providing continuous support for air barrier.
- D. Flashings: Seal top of through-wall flashings to membrane air barrier with a continuous bead of approved sealant recommended by air barrier manufacturer.
- E. Seal punctures, voids, and seams. Patch with approved transition and accessory materials following air barrier manufacturer's recommendations and extend repair beyond repaired areas to maintain continuity.

3.4 APPLICATION

- A. A. General: Apply fluid air-barrier material to form a seal with transition materials and accessories to achieve a continuous air barrier according to air-barrier manufacturer's written instructions. Apply fluid air-barrier material within manufacturer's recommended application temperature ranges.

- B. Membrane Air Barrier: Apply fluid air barrier material in full contact with substrate to produce a continuous seal according to membrane air barrier manufacturers written instructions.
 - 1. Vapor-Permeable Membrane Air Barrier: Total dry film thickness as recommended in writing by manufacturer to meet performance requirements, in a range of 25 – 35 mils (1.0 mm) dry film thickness depending on substrate, applied in one or more equal coats, roller- or spray- applied.
- C. Connect and seal exterior wall air-barrier membrane continuously to subsequently-installed roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, wall openings, and other construction used in exterior wall openings, using approved transitions and accessory materials.
- D. D.Wall Openings: Apply approved sealant to adhere silicone extrusion to perimeter of windows, curtain walls, storefronts, doors, and louvers. Apply [opening transition assembly] [preformed silicone sealant extrusion] according to air barrier transition manufacturer's written instructions.
- E. Seal punctures, voids, and seams. Patch with approved transition and accessory materials following air barrier manufacturer's recommendations and extend repair beyond repaired areas to maintain continuity.
- F. FDo not cover air barrier until it has been tested and inspected by Owner's testing agency.
- G. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.5 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Do not cover installed air barriers until required inspections have been completed.
- C. Owner may retain testing agency to perform the following tests:
 - 1. Verification that substrate preparation meets requirements.
 - 2. Testing and certification that coating materials comply with requirements for thickness and continuity.
 - 3. Testing of application for compliance with adhesion and film thickness requirements.
- D. If testing indicates products or current installation does not meet requirements, Owner may have materials removed from substrates that are not in compliance, and have other necessary corrections made to ensure application meets designated requirements.
- E. Obtain approval of installation procedures by air barrier manufacturer based on mock-up installed in place, prior to proceeding with remainder of installation.
- F. BTesting Agency: Contractor shall engage a qualified Inspector to perform tests and inspections, including documenting of membrane air barrier prior to concealment.
 - 1. Inspections and testing shall be carried out at the following rate:
 - a. Up to 10,000 sq. ft. (930 sq. m): One inspection.
 - b. 10,001 to 35,000 sq. ft. (931 to 3,250 sq. m): Two inspections.
 - c. 35,001 to 75,000 sq. ft. (3,251 to 6,970 sq. m): Three inspections.
 - d. 75,001 to 125,000 sq. ft. (6,971 to 11,610 sq. m): Four inspections.
 - e. 125,001 to 200,000 sq. ft. (11,611 to 18,580 sq. m): Five inspections.
 - f. Over 200,000 sq. ft. (18,580 sq. m): Six inspections.
 - 2. Scope of Testing: Testing shall include the following:
 - a. Qualitative air-leakage testing per ASTM E 1186.
 - b. Quantitative air-leakage testing per ASTM E 783.
 - c. Photo documentation of work to be subsequently concealed.

- G. Coordination of Testing: Cooperate with testing agency. Allow access to work areas and staging. Notify testing agency in writing of schedule for Work of this Section to allow sufficient time for testing and inspection.
 - 1. Do not cover Work until testing and inspection is completed and accepted.
- H. Reporting: Forward written inspection reports to the Architect within 10 working days of the inspection and test being performed.
- I. Correction: Correct deficient applications not passing tests and inspections, make necessary repairs, and retest as required to demonstrate compliance with requirements.

3.6 CLEANING

- A. During completion of this work, remove overspray and excess material, using materials and methods approved by manufacturer that will not damage adjacent materials.
- B. Clean and repair adjacent surfaces damaged by air barrier coating application.

3.7 PROTECTION

- A. Do not leave materials exposed to weather longer than recommended by manufacturer.
- B. Allow air barrier coatings to fully cure before exposure to traffic or other construction operations.
- C. Prevent damage to coatings from construction operations or other causes.
- D. Replace damaged air barrier coatings prior to concealment behind subsequent construction.

END OF SECTION 07 27 26

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SECTION 07 42 13
METAL WALL PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Manufactured metal panels for exterior wall panels, soffit panels, and subgirt framing assembly, with accessory components.

1.2 RELATED REQUIREMENTS

- A. Section 05 40 00 - Cold-Formed Metal Framing: Wall panel substrate.
- B. Section 07 21 00 - Thermal Insulation.
- C. Section 07 25 00 - Weather Barriers: Weather barrier under wall panels.

1.3 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- B. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document); 2015.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data - Wall System: Manufacturer's data sheets on each product to be used, including:
 - 1. Physical characteristics of components shown on shop drawings.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation instructions and recommendations.
- C. Shop Drawings: Indicate dimensions, layout, joints, construction details, support clips, _____, and methods of anchorage.
- D. Samples: Submit two samples of wall panel and soffit panel, 12 inches by 12 inches in size illustrating finish color, sheen, and texture. Include suspension Tee and panel with clip attached.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.

1.5 DELEGATED ENGINEERING REQUIREMENTS

- A. Contract Documents: Concept of work specified by this section is expressed on Drawings and in Specifications however, they may not indicate or specify full extent of work that may be required.
- B. Delegated Engineering Responsibility: Require fabricator to employ a delegated engineering professional to provide engineering for work of this section to comply with concept expressed in Contract Documents.
 - 1. Engineer to withstand structural design loads within limits and under conditions indicated, specified, or required, without material failure or permanent deformation of building structural frame or work specified according to following:
 - a. Applicable local building codes.
 - b. ASCE 7 or the more stringent Building Code requirements.
 - c. Authorities having jurisdiction.
 - d. Criteria indicated Contract Documents.

- C. Prepare engineering calculations, shop drawings, and other submittals and affix professional seal according to respective jurisdictional licensing regulations.
- D. Coordination of Contract Documents and Work.
 - 1. Notify Architect of potential constructability issues between Contract Documents and execution of work. Absence of notice constitutes acceptance of conditions indicated, specified, or required, and changes caused by minor differences between delegated engineering and Contracts Documents will be at no additional cost to Owner.
 - 2. Coordinate installation with other adjoining construction to ensure proper sequencing.
- E. Delegated Engineering Assumptions: Include but not limited to the following.
 - 1. Allowable working stress no more than yield stress of material.
 - 2. Corners and Wind Pressures:
 - a. Corners in typical windload zones: both surfaces shall be assumed to experience inward and outward design pressures simultaneously.
 - b. Partial loading one surface shall also be considered.
 - 3. Safety factors: Engineer structural members to withstand load effects without exceeding allowable working stress as determined by delegated engineering professional consistent with engineering quality standards.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in installing products specified in this section with minimum three years of documented experience.

1.7 MOCK-UPS

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Construct mock-up, ___ feet long by ___ feet wide; include panel and soffit system, glazing, attachments to building frame, associated vapor retarder and air seal materials, weep drainage system, sealants and seals, ____, and related insulation in mock-up.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
- B. Store prefinished material off the ground and protected from weather; prevent twisting, bending, or abrasion; provide ventilation; slope metal sheets to ensure proper drainage.
- C. Prevent contact with materials that may cause discoloration or staining of products.

1.9 FIELD CONDITIONS

- A. Do not install wall panels when air temperature or relative humidity are outside manufacturer's limits.

1.10 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Finish Warranty: Provide 15-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.
- C. Furnish Manufacturer's: 1. Warranty that materials furnished will perform as specified for a period of not less than one (1) year from date of material shipment when installed in accordance with Manufacturer's recommendations. Extended warranty is available upon request.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Metal Wall and Soffit Panels - Concealed Fasteners:
 - 1. Basis-of-Design Product: Provide WinLok™ Exterior Wall System, concealed panel attachment with WinLock clips as manufactured by Gordon, Inc., or comparable product of other manufacturers approved by the Architect.
- B. Metal Soffit Panels - Concealed Fasteners:
 - 1. Basis-of-Design Product: Provide WinLok™ Accessible Soffit System, concealed panel attachment with WinLock clips as manufactured by Gordon, Inc., or comparable product of other manufacturers approved by the Architect.

2.2 METAL WALL PANEL SYSTEM

- A. Wall Panel System: Factory fabricated prefinished metal panel system, site assembled.
 - 1. Provide exterior wall panels and subgirt framing assembly (concealed panel attachment with WinLock clips).
 - 2. Design and size components to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of wall.
 - 3. Maximum Allowable Deflection of Panel: $L/180$ for length(L) of span.
 - 4. Movement: Accommodate movement within system without damage to components or deterioration of seals, movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
 - 5. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
 - 6. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
- B. Exterior Wall Panels:
 - 1. Profile: .
 - a. Round 8" radius, as indicated in the drawings.
 - b. Round 10" radius, as indicated in the drawings.
 - c. Round 12" radius, as indicated in the drawings.
 - d. Flat panel - size varies, see contract documents for sizes.
 - 2. Material: Aluminum sheet, .080 inches minimum thickness.
 - 3. Panel Length: As indicated on the contract documents.
 - 4. Color: Match Architect's sample. Custom Color required to match Dark Antique Cooper per Color Anodic Finish by Lorin www.lorin.com.
- C. Subgirt Framing Assembly:
 - 1. Thermally Broken Exterior Attachment/support framing system:
 - a. Basis-of-Design Product: Provide ThermaZee as manufactured by Knight Wall System, or comparable product of other manufacturers approved by the Architect.
- D. Internal and External Corners: Same material, thickness, and finish as exterior sheets; profile to suit system; shop cut and factory mitered to required angles.

- E. Expansion Joints: Same material, thickness and finish as exterior sheets; ___ gauge, ___ inch thick; manufacturer's standard brake formed type, of profile to suit system.
- F. Trim: Same material, thickness and finish as exterior sheets; brake formed to required profiles.
- G. Anchors: Galvanized steel.

2.3 FINISHES

- A. High Performance Organic Coating System: Multi-coat, high-durable polyester system; color as indicated on drawings.
 - 1. Systems:
 - a. Three-coat in accordance with AAMA 2605.

2.4 ACCESSORIES

- A. Support for Cladding and Continuous Insulation: Thermal clips.
 - 1. Thermally-broken clips that provide attachment support for girts, angles, channels, and other cladding support framing.
 - 2. Fasteners: As recommended by clip manufacturer.
- B. Support for Cladding and Continuous Insulation: Continuous thermal Z-girts.
 - 1. Fiberglass reinforced plastic (FRP) girts that provide cladding attachment support for metal wall panels.
 - 2. Depth: As required for thickness of insulation.
 - 3. Fasteners: As recommended by clip manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that building framing members are ready to receive panels.
- B. Verify weather barrier, see Section 07 25 00, has been installed over wall panel substrate; see Section 05 40 00.

3.2 PREPARATION

- A. Install subgirts perpendicular to panel length, securely fastened to substrates and shimmed and leveled to uniform plane, and spaced at intervals indicated.
- B. Protect surrounding areas and adjacent surfaces from damage during execution of this work.

3.3 INSTALLATION

- A. Install panels on walls and soffits in accordance with manufacturer's instructions.
- B. Fasten panels to structural supports; aligned, level, and plumb.
- C. Use concealed fasteners unless otherwise indicated by Architect.

3.4 CLEANING

- A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
- B. Remove site cuttings from finish surfaces.
- C. Remove protective material from wall panel surfaces.
- D. Upon completion of installation, thoroughly clean prefinished aluminum surfaces in accordance with AAMA 609 & 610.

3.5 PROTECTION

- A. Protect metal wall panels until completion of project.
- B. Touch-up, repair, or replace damaged wall panels or accessories before Date of Substantial Completion.

END OF SECTION 07 42 13

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SECTION 07 42 13.23
METAL COMPOSITE MATERIAL WALL PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Exterior cladding (wall and soffit panels) consisting of formed metal composite material (MCM) sheet, secondary supports, and anchors to structure, attached to solid backup.
- B. Interior cladding (wall and soffit panels) consisting of formed metal composite material (MCM) sheet, secondary supports, and anchors to structure, attached to solid backup.
- C. Matching flashing and trim.

1.2 RELATED REQUIREMENTS

- A. Section 05 40 00 - Cold-Formed Metal Framing: Panel support framing.
- B. Section 07 21 00 - Thermal Insulation: for rigid insulation installed in exterior metal composite material wall panel assemblies.
- C. Section 07 25 00 - Weather Barriers: Water-resistive barrier behind wall panel system.
- D. Section 07 27 26 - Fluid-Applied Membrane Air Barriers: Air barrier behind the wall panel system.
- E. Section 07 62 00 - Sheet Metal Flashing and Trim: Metal flashing components integrated with this wall system.
- F. Section 07 92 00 - Joint Sealants: Sealing joints between siding and adjacent construction and fixtures.

1.3 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- C. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2023.
- D. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- G. ASTM D1781 - Standard Test Method for Climbing Drum Peel for Adhesives; 1998 (Reapproved 2021).
- H. ASTM D1929 - Standard Test Method for Determining Ignition Temperature of Plastics; 2023.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- J. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2023.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Installation Meeting: Convene one week before starting work of this section to verify project requirements, coordinate with installers of other work, establish condition and completeness of building substrate, and review manufacturers' installation instructions and warranty requirements.
 - 1. Require attendance by the installer and relevant sub-contractors.

2. Meet with Owner, Architect, Owner's insurer if applicable, metal composite material panel Installer, metal composite material panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal composite material panels, including installers of doors, windows, and louvers.
3. Include MCM sheet manufacturer's representative and wall system manufacturer's representative to review storage and handling procedures.
4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
5. Review in detail truck transportation, parking, vertical transportation, schedule, personnel, installation of adjacent materials and substrate.
6. Review procedures for protection of work and other construction.
7. Review safety precautions.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data - MCM Sheets: Manufacturer's data sheets on each product to be used, including thickness, physical characteristics, and finish, and:
 1. Finish manufacturer's data sheet showing physical and performance characteristics.
 2. Storage and handling requirements and recommendations.
 3. Fabrication instructions and recommendations.
 4. Specimen warranty for finish, as specified herein.
- C. Product Data - Wall System: Manufacturer's data sheets on each product to be used, including:
 1. Physical characteristics of components shown on shop drawings.
 2. Storage and handling requirements and recommendations.
 3. Installation instructions and recommendations.
 4. Specimen warranty for wall system, as specified herein.
- D. Shop Drawings: Show layout and elevations, dimensions and thickness of panels, connections, details and location of joints, sealants and gaskets, method of anchorage, support clips, exposed fasteners, number of anchors, supports, reinforcement, trim, flashings, and accessories.
 1. Indicate panel numbering system.
 2. Differentiate between shop and field fabrication.
 3. Indicate substrates and adjacent work with which the wall system must be coordinated.
 4. Include large-scale details of anchorages and connecting elements.
 5. Include large-scale details or schematic, exploded or isometric diagrams to fully explain flashing at a scale of not less than 1-1/2 inches per 12 inches.
 6. Include design engineer's stamp or seal on shop drawings for attachments and anchors.
- E. Selection Samples: For each finish product specified, submit at least three sample color chips representing manufacturer's standard range of available colors and patterns.
- F. Verification Samples: For each finish product specified, submit at least three samples, minimum size 12 inch square, and representing actual product in color and texture.
- G. Design Data: Submit structural calculations stamped by design engineer, for Architect's information and project record.
- H. Test Report: Submit test report verifying compliance with NFPA 285 for previously-tested exterior wall assembly.

- I. Manufacturer's Field Reports: Provide within 48 hours of field review. State what was observed and what changes, if any, were requested or required.
- J. Installer's qualification statement.
- K. Testing agency's qualification statement.
- L. Maintenance Data: Care of finishes and warranty requirements.
- M. Executed Warranty: Submit warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. Field Measurements: Verify actual dimensions by field measurement before fabrication; show recorded measurements on shop drawings.
- B. Design Engineer's Qualifications: Design structural supports and anchorages under direct supervision of a Structural Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- C. Manufacturer Qualifications: Company specializing in manufacturing wall panel systems specified in this section.
 - 1. With not less than 20 years of documented experience.
- D. Installer Qualifications: Company specializing in performing work of type specified in this section.
 - 1. With minimum three years of documented experience.
 - 2. Approved by wall panel system manufacturer.
- E. Testing Agency Qualifications: Independent agency experienced in testing assemblies of the type required for this project and having the necessary facilities for full-size mock-up testing of the type specified.

1.7 MOCK-UPS

- A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
- B. Build mockup of typical metal composite material panel assembly including corner, soffit, supports, attachments, and accessories.
- C. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
- D. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original, unopened, undamaged containers with identification labels intact.
 - 1. Protect finishes by applying heavy-duty removable plastic film during production.
 - 2. Package for protection against transportation damage.
 - 3. Provide markings to identify components consistently with drawings.
 - 4. Exercise care in unloading, storing, and installing panels to prevent bending, warping, twisting, and surface damage.
- B. Store products protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
 - 1. Store in well-ventilated space out of direct sunlight.
 - 2. Protect from moisture and condensation with tarpaulins or other suitable weathertight covering installed to provide ventilation.

3. Store at a slope to ensure positive drainage of accumulated water.
4. Do not store in enclosed space where ambient temperature can exceed 120 degrees F.
5. Avoid contact with other materials that might cause staining, denting, or other surface damage.

1.9 FIELD CONDITIONS

- A. Do not install panels when air temperature or relative humidity are outside manufacturer's limits.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal composite material panel systems that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
- B. Finish Warranty: Provide 20-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Metal Composite Material (MCM) Panels:
 1. Basis-of-Design Product: Provide "ALUCOBOND Plus" aluminum faced composite panels as manufactured by 3A Composites: www.alucobondusa.com/#sle, or comparable product of other manufacturers approved by the Architect.

2.2 WALL & SOFFIT PANEL SYSTEM

- A. Wall Panel System: Metal panels, fasteners, and anchors designed to be supported by framing or other substrate provided by others; provide installed panel system capable of maintaining specified performance without defects, damage, or failure.
 1. Provide structural design by or under direct supervision of a Structural Engineer licensed in the State in which the Project is located.
 2. Provide panel jointing and weatherseal using a "wet", sealant-sealed system.
 3. Anchor panels to supporting framing without exposed fasteners.

2.3 PERFORMANCE REQUIREMENTS

- A. Thermal Movement: Provide for free and noiseless vertical and horizontal thermal movement due to expansion and contraction under material temperature range of minus 20 degrees F to 180 degrees F without buckling, opening of joints, undue stress on fasteners, or other detrimental effects; allow for ambient temperature at time of fabrication, assembly, and erection procedures.
- B. Fire Performance: Use test method complying with NFPA 285.

2.4 PANELS

- A. Panels: 1 inch deep pans formed of metal composite material sheet by routing back edges of sheet, removing corners, and folding edges.

1. Reinforce corners with riveted aluminum angles.
2. Provide concealed attachment to supporting structure by adhering attachment members to back of panel; attachment members may also function as stiffeners.
3. Maintain maximum panel bow of 0.8 percent of panel dimension in width and length; provide stiffeners of sufficient size and strength to maintain panel flatness without showing local stresses or read-through on panel face.
4. Secure members to back face of panels using structural silicone sealant approved by MCM sheet manufacturer.
5. Fabricate panels under controlled shop conditions.
6. Where final dimensions cannot be established by field measurement before commencement of manufacturing, make allowance for field adjustments without requiring field fabrication of panels.
7. Fabricate as indicated on drawings and as recommended by MCM sheet manufacturer.
 - a. Make panel lines, breaks, curves, and angles sharp and true.
 - b. Keep plane surfaces free from warp or buckle.
 - c. Keep panel surfaces free of scratches or marks caused during fabrication.
8. Provide joint details providing a watertight and structurally sound wall panel system that allows no uncontrolled water penetration on inside face of panel system.
9. For "dry" jointing, secure extrusions to returned pan edges with stainless steel rivets; provide means of concealed drainage with baffles and weeps for water that might accumulate in members of system.

2.5 MATERIALS

- A. Metal Composite Material (MCM) Sheet: Two sheets of aluminum sandwiching a core of extruded thermoplastic material; no foamed insulation material content.
 1. Overall Sheet Thickness: 4mm (0.157 inch), minimum, unless noted or required to meet specified levelness/flatness tolerances.
 2. Face Sheet Thickness: 0.020 inch, minimum.
 3. Alloy: Manufacturer's standard, selected for best appearance and finish durability.
 4. Bond and Peel Strength: No adhesive failure of the bond between the core and the skin nor cohesive failure of the core itself below 22.4 inch-pound/inch with no degradation in bond performance, when tested in accordance with ASTM D1781, simulating resistance to panel delamination, after 8 hours of submersion in boiling water and after 21 days of immersion in water at 70 degrees F.
 5. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 6. Flammability: Self-ignition temperature of 650 degrees F or greater when tested in accordance with ASTM D1929.
- B. Metal Framing Members: Include sub-girts, zee-clips, base and sill angles and channels, hat-shaped and rigid channels, and furring channels required for complete installation.
 1. Provide material strength, dimensions, configuration as required to meet applied loads and in compliance with applicable building code.
 2. Sheet Steel Components: ASTM A653/A653M galvanized to G90/Z275 or zinc-iron alloy-coated to A60/ZF180; or ASTM A792/A792M aluminum-zinc coated to AZ60/AZM180.
 3. Aluminum Components: ASTM B209/B209M; or ASTM B221 (ASTM B221M).

2.6 FINISHES

- A. Fluoropolymer Coil Coating System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, with at least 80 percent of coil coated metal surfaces having minimum total dry film thickness (DFT) of 0.9 mil, 0.0009 inch; color and gloss to match sample.
- B. Fluoroethylene Vinyl Ether (FEVE) Coating: Superior performing resin based organic powder coatings system complying with AAMA 2605; single coat applications when applied to aluminum with dry film thickness (DFT) of 2 to 3 mil, 0.002 to 0.003 inch; color and gloss as scheduled.
 - 1. Apply coating to exposed metal surfaces with proper preparation and pretreatment in accordance with resin manufacturer's instructions.
- C. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
- D. Exposed Anodized Finish:
 - 1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
 - 2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
- E. Color/Texture: Custom color to match Architect's sample.
 - 1. Color 1: To match curtainwall basis of design color Champagne Anodized by EFCO.
 - 2. Color 2: Black Anodized by Alucobond USA.

2.7 ACCESSORIES

- A. Flashing and Trim: Provide flashing and trim formed from same material as MCM 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 MCM panels.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide ALUCOBOND®; 3A Composites USA Inc.; ALUCOBOND® Axcent™ Trim or comparable product of other manufacturers approved by the Architect.
 - 2. Aluminum Trim: Formed with 0.040-inch (1.00-mm-) thick, coil-coated aluminum sheet facings.
 - 3. Colors: Custom colors to match Architect's sample.
 - a. Color 1: To match curtainwall basis of design color Champagne Anodized by EFCO.
 - b. Color 2: Black Anodized by Alucobond USA.
- B. Support for Cladding and Continuous Insulation: Thermal clips.
 - 1. Thermally-broken clips that provide attachment support for girts, angles, channels, and other cladding support framing.
 - 2. Fasteners: As recommended by clip manufacturer.
- C. Support for Cladding and Continuous Insulation: Continuous thermal Z-girts.
 - 1. Fiberglass reinforced plastic (FRP) girts that provide cladding attachment support for exterior wall cladding.
 - 2. Fasteners: As recommended by clip manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine dimensions, tolerances, and interfaces with other work.

1. Verify that weather barrier system is properly installed; see Section 07 27 26 for requirements.
- B. Examine substrate on-site to determine that conditions are acceptable for product installation in accordance with manufacturer's written instructions.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- D. Notify Architect in writing of conditions detrimental to proper and timely completion of work, and do not proceed with erection until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect adjacent work areas and finish surfaces from damage during installation.
- B. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages in accordance with ASTM C754 and MCM panel manufacturer's written recommendations.

3.3 INSTALLATION

- A. Do not install products that are defective, including warped, bowed, dented, and broken members, and members with damaged finishes.
- B. Comply with instructions and recommendations of MCM sheet manufacturer and wall system manufacturer, as well as with approved shop drawings.
- C. Install wall system securely allowing for necessary thermal and structural movement; comply with wall system manufacturer's instructions for installation of concealed fasteners.
- D. Do not handle or tool products during erection in manner that damages finish, decreases strength, or results in visual imperfection or failure in performance. Return component parts that require alteration to shop for refabrication, if possible, or for replacement with new parts.
- E. Do not form panels in field unless required by wall system manufacturer and approved by the Architect; comply with MCM sheet manufacturer's instructions and recommendations for field forming.
- F. Separate dissimilar metals; use gasket fasteners, isolation shims, or isolation tape where needed to eliminate possibility of electrolytic action between metals.
- G. Where joints are designed for field-applied sealant, seal joints completely with specified sealant.
- H. Install flashings as indicated on shop drawings. At flashing butt joints, provide a lap strap under flashing and seal lapped surfaces with a full bed of non-hardening sealant.
- I. Install square, plumb, straight, and true, accurately fitted, with tight joints and intersections maintaining the following installation tolerances:
 1. Variation From Plane or Location: 1/2 inch in 30 feet of length and up to 3/4 inch in 300 feet, maximum.
 2. Deviation of Vertical Member From True Line: 0.1 inch in 25 feet run, maximum.
 3. Deviation of Horizontal Member From True Line: 0.1 inch in 25 feet run, maximum.
 4. Offset From True Alignment Between Two Adjacent Members Abutting End To End, In Line: 0.03 inch, maximum.
- J. Replace damaged products.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Wall System Manufacturer's Field Services: Provide field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with instructions.

3.5 CLEANING

- A. Ensure weep holes and drainage channels are unobstructed and free of dirt and sealants.
- B. Remove protective film after installation of joint sealers, after cleaning of adjacent materials, and immediately prior to completion of work.
- C. Remove temporary coverings and protection of adjacent work areas.
- D. Clean installed products in accordance with manufacturer's instructions.

3.6 PROTECTION

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

END OF SECTION 07 42 13.23

SECTION 07 42 30
WOOD SIDING RAINSCREEN SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. All work associated with rainscreen system from substrate out including the following:
 - 1. Exterior Hardwood Cladding.
 - 2. Exterior Hardwood Architectural Grille.
 - 3. Secondary metal framing support and mounting system, including anchorages, fasteners, stiffeners, aluminum sub-framing and other components.
 - 4. Flashings, Seals, and Trim.

1.2 RELATED REQUIREMENTS

- A. Section 05 40 00 - Cold-formed Metal Framing" for structural metal stud framing.

1.3 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Building and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

1.4 PRECONSTRUCTION AND PREPARATION

- A. Preinstallation Meeting: Conduct a preinstallation meeting at least one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Examine and verify that job conditions are satisfactory for speedy and acceptable work.
- C. Field Measurements: Secure field measurements before preparation of shop drawings and fabrication for proper fabrication and installation of the work.

1.5 SUBMITTALS

- A. Product Data.
- B. Engineering Analysis and Calculations
- C. Shop Drawings:
 - 1. Indicate all items and connections required for a complete installation, including but not limited to:
 - a. Fasteners
 - b. Wood cladding
 - c. Architectural wood grille
 - d. Sub-framing
 - e. Items not included in this section but required to complete work: cold-formed metal framing.
 - 2. Drawings shall indicate sizes of ventilation openings and methods of preventing unwanted insects or animals from entering cavity behind cladding.
 - 3. Drawings shall indicate adjustment in sub-framing and anchorage components to allow for adjustment and alignment of wood cladding.
 - 4. Drawings to be fully coordinated with adjacent work including but not limited to:
 - a. Masonry wall systems
 - b. Copings
- D. Samples.

1. Components: Submit samples of anchors, fasteners, hardware, assembled cladding sections and other materials as requested by Architect.
2. Finish: Submit color samples for Architects approval as requested.
- E. Attic Stock:
 1. Provide 2 replacement planks of each wood type, finish, and size. Planks to be provided with preparation and fasteners needed for future installation by Owner.
 2. Provide 4 replacement wood grille slats of each type, finish, and size. Slats to be provided with preparation and fasteners needed for future installation by Owner.
- F. Maintenance Data: For each type of product, including related accessories, to include maintenance manuals.
 1. Include methods for maintaining installed products and precautions against cleaning materials and methods detrimental to finishes and performance.
 2. Include repair instructions for chips, abrasions, and graffiti.

1.6 DELEGATED ENGINEERING REQUIREMENTS

- A. Contract Documents: Concept of work specified by this section is expressed on Drawings and in Specifications however, they may not indicate or specify full extent of work that may be required.
- B. Delegated Engineering Responsibility: Require fabricator to employ a delegated engineering professional to provide engineering for work of this section to comply with concept expressed in Contract Documents.
 1. Engineer to withstand structural design loads within limits and under conditions indicated, specified, or required, without material failure or permanent deformation of building structural frame or work specified according to following:
 - a. Applicable local building codes.
 - b. ASCE 7 or the more stringent Building Code requirements.
 - c. Authorities having jurisdiction.
 - d. Criteria indicated Contract Documents.
- C. Prepare engineering calculations, shop drawings, and other submittals and affix professional seal according to respective jurisdictional licensing regulations.
- D. Coordination of Contract Documents and Work.
 1. Notify Owner, Architect and Exterior Wall Consultant of potential constructability issues between Contract Documents and execution of work. Absence of notice constitutes acceptance of conditions indicated, specified, or required, and changes caused by minor differences between delegated engineering and Contracts Documents will be at no additional cost to Owner.
 2. Coordinate installation with other adjoining construction to ensure proper sequencing.
- E. Delegated Engineering Assumptions: Include but not limited to the following.
 1. Allowable working stress no more than yield stress of material.
 2. Corners and Wind Pressures:
 - a. Corners in typical windload zones: both surfaces shall be assumed to experience inward and outward design pressures simultaneously.
 - b. Partial loading one surface shall also be considered.
 3. Safety factors: Engineer structural members to withstand load effects without exceeding allowable working stress as determined by delegated engineering professional consistent with engineering quality standards.

1.7 QUALITY ASSURANCE

- A. Unless approved by the Architect, provide all related products and accessories from one manufacturer.
- B. Ventilated rainscreen system shall provide complete secondary drainage system, draining at base of wall. Supporting substrate for exterior wall cladding shall comply with all current codes and regulations.
- C. Fabricator Qualifications: Company with not less than 5 years experience with successful production of specified work similar in scope of this project; with a record of successful in service performance; and with sufficient capability, facilities, and trained and skilled personnel.
- D. Installer Qualifications:
 - 1. Company with not less than 5 years experience in performing specified work similar in design, products, and extent of scope of this project; with a record of successful in service performance; and with sufficient capability, and trained and skilled personnel.
 - 2. Supervision: Maintain a competent supervisor who is at the project while work is in progress and who is experienced in installing work similar in design, products, and extent of scope of this project.
 - 3. Manufacturer Acceptance: Certified Acceptable by manufacturer to install specified work.

1.8 PERFORMANCE REQUIREMENTS

- A. Building Structural Frame Movement Design Criteria: Obtain necessary projected data from Structural Engineer of Record and make such provisions in the work as may be necessary. Identify movement compliance on Shop Drawings.
 - 1. Floor live load vertical deflection
 - 2. Lateral deflection.
 - 3. Interstory drift.
 - 4. Shrinkage and creep.
 - 5. Thermal movement.
 - 6. Differential foundation settlement.
- B. Wind Resistance Criteria: Withstand load effect of 150% of inward positive and outward negative design wind load pressures as indicated on Contract Documents, acting inward and outward normal to plane of wall according to ASTM E 330.
 - 1. Net permanent deformation of structural members not more than 0.2% or L/1000.
 - 2. No failure or gross permanent distortion of framing members, anchors or connections, or any other portion of system.
- C. Manufacturers published performance data:
 - 1. Meet all of the manufacturers published performance data regarding rain screen.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Materials must be transported flat and kept dry and protected from the elements and handled with care.
- B. Storage and Protection: Materials must be stored flat and kept dry in a warehouse/storage facility, protected from exposure to harmful weather conditions, at temperatures and humidity conditions recommended by the manufacturer.
- C. Handling: Open crate within 72 hours of material delivery. Remove extra top panel and
 - 1. inspect contents by lifting each panel vertically to prevent chafing of the decorative face. Protect materials during handling to prevent damage.
- D. Re-package per the original packaging until material is ready to install.

1.10 FIELD CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Field Measurements
 - 1. Verify actual measurements by field measurements before material fabrication, and show recorded measurements on shop drawings.
 - 2. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

1.11 WARRANTY

- A. Furnish Manufacturers standard warranty: Submit for Owners acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to and not a limitation of other rights Owner may have under contract documents.
- B. Furnish repair and replacement warranty for a period of no less than 5 years from the date of substantial completion agreeing to repair or replace defects, faulty work and failures, signed by authorized representatives of Manufacturer, fabricator, and installer.
- C. Defects, faulty work and failures include, but not limited to, following:
 - 1. Structural failure of components resulting from specified forces and loads.
 - 2. Thermal movement causing damage to interior or exterior finishes, buckling, joint opening, excessive strain on structural members, undue stress on fasteners and anchors, failure of sealants, reduction of performance, or other detrimental effects.
 - 3. Noise or vibration.
 - 4. Deflection exceeding specified limits.
 - 5. Loosening or weakening of fasteners, anchors, and other components.
 - 6. Failure of fasteners, anchors, and attachment metals.
 - 7. Failures of finishes.
 - 8. This warranty and its enforcement shall not deprive the Owner of other action, right, or remedy available to him.

PART 2 PRODUCTS

2.1 EXTERIOR HARDWOOD CLADDING

- A. Basis of Design: Subject to compliance with requirements, provide product by one of the following or APPROVED EQUAL:
 - 1. Cumaru by Iron Woods
 - a. Timber Holdings Architectural Products; www.ironwoods.com.
 - b. Potential Equal: Nova USA Wood Products; www.novausawood.com.
- B. Hardwood Cladding
 - 1. Thickness: .72 inches
 - 2. Width: As indicate in Drawings.
 - 3. Clips: Concealed 'Vanish' system or similar, aluminum or stainless steel.
 - 4. Fasteners: Concealed, stainless steel
- C. Fabricate cladding and accessory items in accordance with manufacturer's recommendations and approved submittals.

2.2 ALUMINUM SUB-FRAMING FOR VERTICAL WOOD CLADDING

- A. All rainscreen framing components to be aluminum unless otherwise noted.
 - 1. Knightwall HCI Girt System by IronWood or APPROVED EQUAL.
- B. Fasteners: Stainless Steel
- C. Finish: Paint matte black where exposed to view.

2.3 ACCESSORIES

- A. Self-adhering, Pre-Compressed, Self-Expanding, Breathable Joint Seal.
 - 1. Provide and install product by Emseal (Backerseal) or Willseal (600 / 600S) as indicated in Drawings. Color - Black.
- B. Insect / Bird Resistant Screen.
 - 1. Provide and install exterior-rated, reticulated open-cell polymer filter suitable to allow passage of air ventilation but resist dust, insect and/or bird passage. As indicated in Drawings. Color - Black.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine alignment of backup structure prior to installing sub-frame. Do not proceed until all defects are corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's Installation Instructions.
- B. Comply with Delegated engineering and shop drawings.
- C. Comply with Contract documents and approved submittals.
- D. Ventilation Cavity: Provide an uninterrupted, unobstructed ventilation cavity of the depth shown on drawings; depth not to be less than that required by manufacturer. Should an conditions arise that may obstruct cavity, alert Architect immediately.
- E. Anchor components securely and permanently in place, shimming and using attachment methods and devices that permit adjustment for construction tolerances, irregularities, and alignment.
- F. Prevent galvanic action and other forms of corrosion by isolating metals and other materials from direct contact with incompatible material with shims or bituminuous paint.
- G. Anchors fastener, joints and splices shall be concealed, unless noted otherwise. Where fasteners are permitted in exposed work, finish to match adjacent surfaces.
- H. Assemble cladding in orientation indicated plumb, level, true, and in alignment with established lines.
- I. Allow for free and noiseless expansion and contraction movement due to varying thermal conditions.
- J. Assemble cladding and other components to drain water passing joints, condensation
 - 1. occurring within framing members and moisture migrating within assembly to exterior.
- K. Tolerances: Install cladding and components plumb, level, accurately aligned, and located in reference to column lines and floor levels. Adjust work to conform to tolerances indicated below. Tolerances indicated below are maximums and are not cumulative.
 - 1. Level, plumb, and location: 1/8" in 15', non-accumulative.
 - 2. Alignment of profiles: 1/16"
 - 3. Longitudinal or diagonal warp: 1/16" in 10' straight edge.
- L. Clearance: Allow for minimum 1" cavity behind cladding for sufficient air flow.

- M. Accessory items: Provide corner profiles, gaskets, trim and other accessory items as required and appropriate for use with adjoining construction.

3.3 FIELD QUALITY CONTROL

- A. Manufacturers Field Inspection: Manufacturers technical representative shall inspect first day's work and periodically inspect work to ensure installation is proceeding in accordance with manufacturer's designs, recommendations, instructions and warranty requirements. Representative shall submit written reports of each visit indicating observations, findings, and conclusions of inspections.
 - 1. Any work found to be non-compliant shall be repaired at no cost to owner.

3.4 PROTECTION

- A. General Requirements: Provide final protection and maintain conditions, in a manner acceptable to manufacturer, fabricator, and installer which ensures cladding will be without damage or deterioration at time of substantial completion.
- B. Do not use abrasive cleaners or cleaning tools. Dry wipe down cladding sections as work progresses.
- C. Provide final cleaning of the wall system.

3.5 ACCEPTANCE

- A. Remove and replace materials which are damaged, do not comply with Contract Documents, or in the opinion of the Architect, do not conform to the specification requirements. Eliminate evidence of replacement, and replace material damaged in the process.

END OF SECTION 07 42 30

SECTION 07 42 43
EXTERIOR HIGH PRESSURE LAMINATED COMPOSITE PANELS

EXTERIOR HIGH PRESSURE LAMINATED COMPOSITE PANELS

1.1 SECTION INCLUDES

- A. Exterior high pressure laminate composite panels at walls and soffits.

1.2 RELATED REQUIREMENTS

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination Procedures:
 - 1. Coordinate work results of this Section with other work.
- B. Preinstallation Meeting Attendees and Procedures:
 - 1. Conduct meeting one week, minimum, before starting Work of this Section.
 - 2. Additional Attendees:
 - 3. Additional Agenda Items:

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings.
 - 1. Show fabrication and installation layouts including direction of wood grain finish on panels, details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, accessories; and special details.
- C. Samples:
 - 1. Panels: Submit three 8.5 by 11 inches (22 by 28 cm) for each finish.
 - 2. Accessories: 8 inch (20 cm) long section.
 - 3. Assembly Samples: Assemble panel, [15 by 8 inches (38 by 20 cm)] in size showing subframe and fasteners.

1.5 INFORMATIONAL SUBMITTALS

- A. Certificates:
 - 1. Manufacturer Certificate: Intertek Code Compliance Research Report (CCRR) indicating compliance with IBC.
 - a. Installation instructions: Submit manufacturer instructions including surface preparation and installation procedures.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panels.
- B. Warranty Documentation: For panels.

1.7 QUALITY ASSURANCE

- a. Mockups: Construct mockup description; size, demonstrating product interfaces, intersections, and terminations.
 - 1) Approved mockups establish products and work results standard.
 - 2) Approved mockups may remain as a part of the Work.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Refer to manufacturer user manual.
 - 1. Transport panels strapped down horizontally to avoid sliding; protect edges and corners.
- B. Storage: Refer to manufacturer user manual.
 - 1) Maintain in original protective package until use.
 - 2) Store in a clean, dry, enclosed, and ventilated area.
 - (a) Temperature: 50 degrees F (10 degrees C), minimum, 80 degrees F (27 degrees C), maximum.
 - (b) Humidity: 30 percent, minimum, 70 percent, maximum.
 - 3) Store horizontally on elevated platforms, with supports 24 inches (60 cm) apart, maximum.
 - 4) Cover panels to match original packaged condition while not in use.
 - 5) Handling: Lift and move panels evenly to avoid scratching the decorative surface.

1.9 FIELD CONDITIONS

- a. Existing Conditions: Verify field measurements before fabrication. Show field measurements on Shop Drawings.
 - 1) Bearing wall must be plumb, with a maximum deviation of 1/8 inch (3 mm) over 40 inches (102 cm).

1.10 WARRANTY

- A. Manufacturer Warranty:
 - 1. Warrant against product failure.
 - a. Warranty Period: 10 years.

1.11 REFERENCE STANDARDS

- A. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2019.
- B. ASTM D1037 - Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials; 2012 (Reapproved 2020).
- C. ASTM D2247 - Standard Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity; 2015 (Reapproved 2020).
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- E. ASTM G155 - Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials; 2021.
- F. ICC-ES AC92 - Acceptance Criteria for Polymer-Based, Polymer-Modified and High-Pressure Laminate Exterior and Interior Wall Cladding; 2013, with Editorial Revision (2021).

PART 2 PRODUCTS

2.1 WALL AND SOFIT PANELS

- A. High Pressure Laminate Wood Veneer Wall and Soffit Panels: High density panels with natural wood veneers, fire-resistant thermoset phenolic resin core, and UV-resistant coating.
 - 1. Basis-of-Design Product: Provide NATURCLAD-W F as manufactured by PARKLEX PRODEMA, or comparable product of other manufacturers approved by the Architect.
 - 2. Thickness: 3/8 inch (10 mm).

3. Size: See Drawings.
 4. Color: White America Oak, to match interior wall panels.
 5. Joint Width: 1/4 inch (6 mm).
 6. Installation Method: Concealed fastening with hanging hook.
 7. Physical Properties:
 8. Modulus of Elasticity: 1,500,000 psi minimum, ASTM D1037.
 9. Flexural Strength: 9,000 psi minimum crossgrain, 15,000 psi minimum longgrain, ASTM D1037.
 - a. Freeze-Thaw Resistance: No change, ICC-ES AC92 Section 3.2.2
 - b. Water Resistance: No change, ASTM D2247.
 - c. Resistance to Weathering: No change after 2,000 hours, minimum, ASTM G155.
 - d. Salt Spray Resistance: No change after 300 hours, minimum, ASTM B117.
- B. ACCESSORIES
1. Manufacturer standard components as required for complete installation:
 2. Select one or more of installation system components below.
 3. Concealed Fastening with Hanging Hooks: Aluminum J channels, hanging rails, hanging hooks, clamping screws, levelling screws, fixing screws.
- C. PERFORMANCE
1. Structural Design Criteria and Loads: See Structural Drawings.
 2. PARKLEX PRODEMA products meeting ASTM E84 include NATURCLAD-W, NATURCLAD-B, NATURSIDING-W, and NATURSIDING-B.
 3. Surface Burning Performance: ASTM E84 Class A.
 4. Flame Spread Index: 25, maximum.
 5. Smoke Developed Index: 450, maximum.
 - a. Environmental Performance:
 6. Expansion and Contraction: Withstand 120 degree F (67 degree C) ambient and 180 degree F (100 degree C) surface thermal cycling without failure.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance.
1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. PREPARATION
1. Condition product per manufacturer recommendations.
- C. INSTALLATION, GENERAL
1. Follow manufacturer instructions.
 2. Anchor panels and sub-framing securely per engineering recommendations and approved Shop Drawings to allow for necessary movement and structural support.
 3. Cut and drill panels, confirming fixed and floating points, and locate fastener hole spacing according to manufacturer recommendations.
 4. Install plumb, level, and accurately spaced according to manufacturer recommendations and approved submittals and Shop Drawings.

5. Fasten panels with fasteners approved for use with supporting substrate.
 6. Maintain 3/4 inch (20 mm) minimum air space behind panels.
 7. Maintain base and head ventilation spaces of 3/4 inch (20 mm), minimum.
 8. Fastener and hanging hooks to edge distance within manufacturer recommendation.
 9. Replace damaged panels.
- D. INSTALLATION, CONCEALED FASTENING SYSTEM
1. Install hanging rails over uninterrupted vertical subframe components 3/4 inch (20 mm) deep minimum, spaced per manufacturer recommendations.
 2. Install hooks on back of panels per manufacturer instructions.
 3. Hang hooks on rails, adjust height for consistent joint spacing and lock panel in place horizontally with screw through top center hook.
 4. Maintain gap between panels of 1/4 inch (6 mm), minimum.
 5. Maintain distance from hanging hook to panel edge per manufacturer recommendations.
- E. CLEANING
1. Follow manufacturer cleaning instructions.
 2. Remove protection film immediately after installation.
 3. Clean finished surfaces as recommended by panel manufacturer; do not use abrasive cleaners.

END OF SECTION 07 42 43

SECTION 07 54 00
THERMOPLASTIC MEMBRANE ROOFING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Adhered system with thermoplastic roofing membrane.
- B. Insulation, flat and tapered.
- C. Vapor retarder.
- D. Deck sheathing.
- E. Cover boards.
- F. Roofing cant strips, stack boots, and walkway pads.

1.2 RELATED REQUIREMENTS

- A. Section 05 31 00 - Steel Decking: Placement of acoustical insulation for deck flutes.
- B. Section 06 10 00 - Rough Carpentry: Wood cant strips.
- C. Section 07 62 00 - Sheet Metal Flashing and Trim: Roof flashing and counterflashing.
- D. Section 07 72 00 - Roof Accessories: Roof walkways and platform

1.3 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA (RM)'s "The NRCA Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.4 REFERENCE STANDARDS

- A. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2017.
- B. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2023a.
- C. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials; 2017.
- D. ASTM D1079 - Standard Terminology Relating to Roofing and Waterproofing; 2020.
- E. ASTM D6878/D6878M - Standard Specification for Thermoplastic Polyolefin-Based Sheet Roofing; 2021.
- F. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2023.
- G. ASTM E108 - Standard Test Methods for Fire Tests of Roof Coverings; 2020a.
- H. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces; 2011 (Reapproved 2019).
- I. ASTM G154 - Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials; 2023.
- J. ASTM G155 - Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials; 2021.
- K. CRRC-1 - CRRC-1 Roof Product Rating Program Manual; 2024.
- L. FM 4470 - Examination Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction; 2022.
- M. FM DS 1-28 - Wind Design; 2015, with Editorial Revision (2024).
- N. NRCA (RM) - The NRCA Roofing Manual; 2024.
- O. NRCA (WM) - The NRCA Waterproofing Manual; 2021.

- P. UL 580 - Standard for Tests for Uplift Resistance of Roof Assemblies; Current Edition, Including All Revisions.
- Q. UL 790 - Standard for Standard Test Methods for Fire Tests of Roof Coverings; Current Edition, Including All Revisions.
- R. UL 1897 - Uplift Tests for Roof-Covering Systems; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data indicating membrane materials, flashing materials, insulation, vapor retarder, surfacing, and fasteners.
- C. Shop Drawings: Submit drawings that indicate joint or termination detail conditions, conditions of interface with other materials, and setting plan for tapered insulation.
- D. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.
- E. Manufacturer's Certificate:
 - 1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - a. Submit evidence of compliance with performance requirements.
 - 2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.
- F. Product Test Reports: For roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.
- G. Evaluation Reports: For components of roofing system, from ICC-ES.
- H. Manufacturer's qualification statement.
- I. Installer's qualification statement.
- J. Warranty Documentation:
 - 1. Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
 - 2. Submit installer's written verification that installation complies with warranty conditions for waterproof membrane.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of this section with at least three years of documented experience and approved by manufacturer.
 - 1. Is eligible to receive manufacturer's special warranty.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original containers, dry and undamaged, with seals and labels intact, unless otherwise indicated.
- B. Store materials in weather protected environment, clear of ground and moisture.
 - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.

- D. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- E. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.8 FIELD CONDITIONS

- A. Do not apply roofing membrane during unsuitable weather.
- B. Do not apply roofing membrane when ambient temperature is below 40 degrees F or above 90 degrees F, not to exceed manufacturer recommendations.
- C. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.
- E. Schedule applications so that no partially completed sections of roof are left exposed at end of workday.

1.9 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 30 years from date of substantial completion.
 - 2. Special warranty includes roof membrane, base flashings, and other components of roofing system.
 - 3. For repair and replacement include costs of both material and labor in warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Thermoplastic Polyolefin (TPO) Membrane Roofing Materials:
 - 1. Carlisle SynTec Systems: www.carlisle-syntec.com/#sle.
 - 2. Elevate: www.holcimelevate.com/#sle.
 - 3. GAF: www.gaf.com/#sle.
 - 4. GenFlex Roofing Systems, LLC: www.genflex.com/#sle.
 - 5. Johns Manville: www.jm.com/#sle.
 - 6. Versico Roofing Systems: www.versico.com/#sle.
- B. Insulation:
 - 1. Carlisle SynTec Systems: www.carlisle-syntec.com/#sle.
 - 2. GAF: www.gaf.com/#sle.
 - 3. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
 - 4. Versico Roofing Systems: www.versico.com/#sle.
 - 5. Johns Manville; A Berkshire Hathaway Company
- C. Cover Boards:

2.2 ROOFING - UNBALLASTED APPLICATIONS

- A. Thermoplastic Membrane Roofing: One ply membrane, fully adhered, over insulation and insulated cover board.

- B. Roofing Assembly Requirements:
1. General Performance: Installed roofing system and 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. Roof system and flashings shall remain watertight.
 - a. Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G154, or ASTM G155.
 - b. Puncture Resistance: Roof membrane shall resist puncture damage when tested according to FTM 101C, method 2031.
 2. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.
 3. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897:
 - a. Zone 1 (Roof Area Field): **As indicated on drawings.**
 - b. Zone 2 (Roof Area Perimeter): **As indicated on drawings.**
 - c. Zone 3 (Roof Area Corners): **As indicated on drawings.**
 4. ENERGY STAR Listing: Roofing system shall be listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
 5. Complete System Thermal Resistance, R-Value: **See Drawings.**
 6. Energy Performance: Roofing system shall have an initial solar reflectance of not less than 0.70 and an emissivity of not less than 0.75 when tested according to CRRC-1.
 7. Exterior Fire-Test Exposure: ASTM E108 or UL 790, **Class C**; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 8. Solar Reflectance Index (SRI): Minimum of 82 based on three-year aged value; if three-year aged data is not available, minimum of 97 initial value.
 - a. Calculate SRI in accordance with ASTM E1980.
 - b. Field applied coating may not be used to achieve specified SRI.
- C. Acceptable Insulation Types - Tapered Application: Any of types specified.
1. Tapered polyisocyanurate board.

2.3 MEMBRANE ROOFING AND ASSOCIATED MATERIALS

- A. Membrane Roofing Materials:
1. TPO: Thermoplastic polyolefin (TPO) complying with ASTM D6878/D6878M, sheet contains reinforcing fabrics or scrims.
 - a. Thickness: 80 mil, 0.080 inch, minimum.
 2. Sheet Width: Factory fabricated into widest possible sheets.
 3. Color: White.
- B. Seaming Materials: As recommended by membrane manufacturer.
- C. Vapor Retarder: Material approved by roof manufacturer complying with requirements of fire rating classification; compatible with roofing and insulation materials.
1. Fire-retardant self-adhered.
 2. Vapor Permeability: .04 perm inch, maximum, measured in accordance with ASTM E96/E96M.

3. Thickness: 30 mils, minimum.
- D. Flexible Flashing Material: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils thick, minimum, of same color as TPO sheet.

2.4 DECK SHEATHING

- A. Deck Sheathing: Glass-mat faced gypsum panels complying with ASTM C1177/C1177M.
 1. Thickness: 1/2 inch, Type X, fire-resistant.

2.5 COVER BOARDS

- A. Cover Boards: Faced, and with high compressive strength polyisocyanurate (ISO) insulation complying with ASTM C1289, and the following characteristics:
 1. Classifications: Type II, Class 4 - Faced with coated or uncoated glass fiber mat facers on both major surfaces of the core foam.
 2. Grade and Compressive Strength: Grade 2, 110 psi.
 3. Board Thickness: 1/2 inch, maximum.

2.6 INSULATION

- A. Polyisocyanurate (ISO) Board Insulation: Rigid cellular foam, complying with ASTM C1289.
 1. Classifications:
 - a. Type II: Faced with either cellulosic facers or glass fiber mat facers on both major surfaces of the core foam.
 - 1) Class 1 - Faced with glass fiber reinforced cellulosic facers on both major surfaces of the core foam.
 - 2) Compressive Strength: Classes 1-2-3, Grade 2, 20 psi (138 kPa), minimum.
 - 3) Thermal Resistance, R-value: At 1-1/2 inches thick; Class 1, Grades 1-2-3, 8.4 (1.48), minimum, at 75 degrees F. Maintain a min. R-30.
 2. Board Size: 48 by 96 inches.
 3. Board Thickness: As indicated in drawings. Installed in a min. of 2 layers with staggered panel joints.
 4. Tapered Board: Slope as indicated; minimum thickness 1/4 inch; fabricate of fewest layers possible.
 - a. Slope:
 - 1) Roof Field: **1/4 inch per foot (1:48)** unless otherwise indicated on Drawings.
 - 2) Saddles and Crickets: **1/2 inch per foot (1:24)** unless otherwise indicated on Drawings.

2.7 ACCESSORIES

- A. Stack Boots: Prefabricated flexible boot and collar for pipe stacks through membrane; same material as membrane.
- B. Cant and Edge Strips: Backer rod, compatible with roofing materials; other configurations as detailed.
- C. Sheathing Joint Tape: Paper type, ___ inches wide, self adhering.
- D. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.
- E. Membrane Adhesive: As recommended by membrane manufacturer.
 1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
 2. Adhesives and sealants shall comply with the following limits for VOC content:
 - a. Plastic Foam Adhesives: 50 g/L.
 - b. Gypsum Board and Panel Adhesives: 50 g/L.
 - c. Multipurpose Construction Adhesives: 70 g/L.

- d. Fiberglass Adhesives: 80 g/L.
- e. Contact Adhesives: 80 g/L.
- f. PVC Welding Compounds: 510 g/L.
- g. Other Adhesives: 250 g/L.
- h. Single-Ply Roof Membrane Sealants: 450 g/L.
- i. Non-membrane Roof Sealants: 300 g/L.
- j. Sealant Primers for Nonporous Substrates: 250 g/L.
- k. Sealant Primers for Porous Substrates: 775 g/L.
- 3. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- F. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
- G. Insulation Adhesive: As recommended by insulation manufacturer.
- H. Walkway Pads: Suitable for maintenance traffic, contrasting color or otherwise visually distinctive from roof membrane.
 - 1. Composition: Roofing membrane manufacturer's standard or product compatible with roof system.
 - 2. Size: As indicated on drawings, but no less than 30" width.
 - 3. Surface Color: Gray.
- I. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces and site conditions are ready to receive work.
- B. Verify deck is supported and secure.
- C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system as required in Section 50 31 00 - Steel Decking.
- D. Verify deck surfaces are dry and free of snow or ice.
- E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

3.2 PREPARATION - METAL DECK

- A. Install deck sheathing on metal deck:
 - 1. Lay with long side at right angle to flutes; stagger end joints; provide support at ends.
 - 2. Cut sheathing cleanly and accurately at roof breaks and protrusions to provide smooth surface.
 - 3. Tape joints.

3.3 INSTALLATION, GENERAL

- A. Perform work in accordance with manufacturer's instructions, NRCA (RM), and NRCA (WM) applicable requirements.
- B. Do not apply roofing membrane during cold or wet weather conditions.
- C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.

- D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

3.4 INSTALLATION - VAPOR RETARDER AND INSULATION, UNDER MEMBRANE

- A. Install vapor retarder to deck surface with adhesive in accordance with manufacturer's instructions.
 - 1. Extend vapor retarder under cant strips and blocking to deck edge.
 - 2. Install flexible flashing from vapor retarder to air seal material of wall construction, lap and seal to provide continuity of the air barrier plane.
- B. Ensure vapor retarder is clean and dry, continuous, and ready for application of insulation.
- C. Attachment of Insulation:
 - 1. Mechanically fasten first layer of insulation to deck in accordance with roofing manufacturer's instructions and FM DS 1-28 Factory Mutual requirements.
 - 2. Embed second layer of insulation into full bed of adhesive in accordance with roofing and insulation manufacturers' instructions.
- D. Lay subsequent layers of insulation with joints staggered minimum 6 inches from joints of preceding layer.
- E. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.
- F. On metal deck, place boards parallel to flutes with insulation board edges bearing on deck flutes.
- G. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
- H. Do not install more insulation than can be covered with membrane in same day.

3.5 INSTALLATION - COVER BOARDS

- A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction.
 - 1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - 2. At internal roof drains, conform to slope of drain sump.
 - a. Trim cover board so that water flow is unrestricted.
 - 3. Cut and fit cover board tight to nailers, projections, and penetrations.
 - 4. Loosely lay cover board over substrate.
 - 5. Adhere cover board to substrate using adhesive.

3.6 INSTALLATION - MEMBRANE

- A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.
 - 1. Allow to relax before installing.
- B. Shingle joints on sloped substrate in direction of drainage.
- C. Fully Adhered Application: Apply adhesive to substrate at rate as required by manufacturer's written instructions. Fully embed membrane in adhesive except in areas directly over or within 3 inches of expansion joints. Fully adhere one roll before proceeding to adjacent rolls.
- D. Overlap edges and ends and seal seams by heat welding, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.
 - 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.
 - 2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.

- 3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements
- E. At intersections with vertical surfaces:
 - 1. Extend membrane over cant strips and up a minimum of 4 inches onto vertical surfaces.
 - 2. Fully adhere flexible flashing over membrane and up to nailing strips.
- F. Around roof penetrations, seal flanges and flashings with flexible flashing.
- G. Coordinate installation of roof drains, sumps, and gutters and related flashings.

3.7 INSTALLATION - WALKWAYS

- A. Install flexible walkways at the following locations:
 - 1. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations, or **as indicated on Drawings**.
- B. Provide 6-inch (76-mm) clearance between adjoining pads.
- C. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.8 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.
- C. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.9 CLEANING

- A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
- B. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and comply with their documented instructions.
- C. Repair or replace defaced or damaged finishes caused by work of this section.

3.10 PROTECTION

- A. Protect installed roofing and flashings from construction operations.
- B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.
- C. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

END OF SECTION 07 54 00

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Formed roof-drainage sheet metal fabrications (gutter and downspouts).
- B. Formed low-slope roof sheet metal fabrications.
- C. Formed wall sheet metal fabrications.
- D. Formed equipment support flashing.
- E. Fabricated sheet metal items, including flashings.
- F. Sheet metal splash pans.

1.2 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry, for wood nailers, curbs, and blocking.

1.3 REFERENCE STANDARDS

- A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2020.
- B. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- C. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- F. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.
- G. ASTM B32 - Standard Specification for Solder Metal; 2020.
- H. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- I. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- J. ASTM C1311 - Standard Specification for Solvent Release Sealants; 2022.
- K. ASTM D1187/D1187M - Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal; 1997 (Reapproved 2018).
- L. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2007 (Reapproved 2018).
- M. CDA A4050 - Copper in Architecture - Handbook; current edition.
- N. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section at **Project Site**.

1.5 COORDINATION

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

1.6 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
- C. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
 - 1. Detail formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches.
- D. Samples: Submit two samples, 12 inches long by actual width, illustrating metal finish color.

1.7 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.
- B. Fabricator and Installer Qualifications: Company specializing in sheet metal work with 3 years of documented experience.

1.8 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.

1.9 WARRANTY

- A. See Section 01 78 00-Closeout Submittals for additional warranty requirements.
- B. Finish Warranty: Provide 20-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. SPRI Wind Design Standard: Manufacture and install roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:
 - 1. Design Pressure: **As indicated on Drawings.**
- D. Thermal Movement: Design system to accommodate without deformation anticipated thermal movement over ambient temperature range of 120 degrees F; 180 degrees F, material surfaces.

2.2 SHEET MATERIALS

- A. Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; shop pre-coated with PVDF coating.
 - 1. Fluoropolymer Coating: High performance organic powder coating, AAMA 2604; multiple coat, thermally cured fluoropolymer finish system.
 - 2. Polyvinylidene Fluoride (PVDF) Coating: Superior performing organic powder coating, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system.
 - 3. Color: As indicated on drawings.
 - 4. Color: As selected by Architect from manufacturer's custom and from manufacturer'd full range colors.
 - 5. Surface: Smooth, flat.
- B. Anodized Aluminum: ASTM B209/B209M, 3005 alloy, H12 or H14 temper; anodized finish to match curtain wall system color.
 - 1. Clear Anodized Finish: AAMA 611, AA-M12C22A41, Class I, clear anodic coating not less than 0.7 mil, 0.0007 inch thick.
 - 2. Color Anodized Finish: AAMA 611, AA-M12C22A42/44, Class I, integrally or electrolytically colored anodic coating not less than 0.18 mil, 0.00018 inch thick.
 - a. Color: As selected by Architect from manufacturer's standard colors.
 - b. Color Range: 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.
- C. Stainless Steel: ASTM A666, Type 304 alloy, soft temper, smooth No. 4 - Brushed finish.

2.3 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
 - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM, PVC, or TPO sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 - 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 - 3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
 - 4. Fasteners for Zinc-Coated (Galvanized) and Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A153/A153M or ASTM F 2329.
- C. Solder:

1. For Zinc-Coated (Galvanized) Steel: ASTM B32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead with maximum lead content of 0.2 percent.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
- E. Elastomeric Sealant: ASTM C920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- H. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D1187/D1187M.
- I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.4 FABRICATION

- A. General: Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
 1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
 4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances:
 1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
 2. 2Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
 2. Use lapped expansion joints only where indicated on Drawings.
- D. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- E. Form pieces in longest possible lengths.
- F. Hem exposed edges on underside 1/2 inch; miter and seam corners.
- G. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- H. Fabricate corners from one piece with minimum 18-inch long legs; seam for rigidity, seal with sealant.
- I. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.

- J. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- K. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.
- L. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength in locations not exposed to view.
- M. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength in locations not exposed to view.
- N. Do not use graphite pencils to mark metal surfaces.

2.5 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Roof Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum 96-inch-long, but not exceeding 12-foot-long sections. Furnish with 6-inch- wide, joint cover plates.
 - 1. Joint Style: Overlapped, 4 inches wide.
 - 2. Fabricate with scuppers spaced 10 feet apart, to dimensions required with 4-inch-wide flanges and base extending 4 inches beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.
 - 3. Fabricate from the Following Materials:
 - a. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick - 24 GA.
- B. Copings: Fabricate in minimum 96-inch-long, but not exceeding 12-foot- long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, solder or weld watertight. Shop fabricate interior and exterior corners.
 - 1. Coping Profile: As indicated on drawings.
 - 2. Joint Style: Butted with expansion space and 6-inch-wide, concealed backup plate.
 - 3. Fabricate from the Following Materials:
 - 4. Aluminum-Zinc Alloy-Coated Steel: 0.040 inch thick.
- C. Roof-to-Wall Transition Expansion-Joint Cover: Fabricate from the following materials:
 - 1. Aluminum-Zinc Alloy-Coated Steel: 0.034 inch thick - 22 GA.
- D. Base Flashing: Fabricate from the following materials:
 - 1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick - 24 GA.
- E. Counterflashing: Fabricate from the following materials:
 - 1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick - 26 GA.
- F. Flashing Receivers: Fabricate from the following materials:
 - 1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick - 26 GA.
- G. Roof-Penetration Flashing: Fabricate from the following materials:
 - 1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick - 24 GA.
- H. Roof-Drain Flashing: Fabricate from the following materials:
 - 1. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch thick.

2.6 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Equipment Support Flashing: Fabricate from the following materials:
 - 1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick - 24 GA.
- B. Overhead-Piping Safety Pans: Fabricate from the following materials:

1. Galvanized Steel: 0.040 inch (1.02 mm) thick - 20 GA.
2. Aluminum-Zinc Alloy-Coated Steel: 0.040 inch (1.02 mm) thick 20 GA.
- C. Other Flashings and Trim pieces (including interior locations see drawings)
 1. Unbroken face dimension of 6" or less:
 - a. Aluminum: 0.040 inch thick.
 2. Unbroken face dimension of 6"-12":
 - a. Aluminum: 0.080 inch thick.
 3. Foundation Protection Cover: Fabricate from the following materials:
 - a. Aluminum-Zinc Alloy-Coated Steel: 0.034 inch thick - 22 GA.
 4. See Drawings for panels of larger dimensions. If gauge or thickness not directly stated, thickness shall be as recommended for brake metal flashing in SMACNA (ASMM).

2.7 GUTTERS AND DOWNSPOUTS

- A. Gutters: SMACNA (ASMM) Rectangular profile.
- B. Downspouts: Rectangular profile.
- C. Accessories: Profiled to suit gutters and downspouts.
 1. Anchorage Devices: In accordance with SMACNA (ASMM) requirements.
 2. Gutter Supports: Brackets.
 3. Downspout Supports: Brackets.
- D. Splash Pans: Same metal type as downspouts, formed to ___ by ___ inch size; rolled sides of ___ inch high for inverted pan placement.
- E. Splash Pads: Precast concrete type, of size and profiles indicated; minimum 3,000 psi at 28 days, with minimum 5 percent air entrainment.
- F. Seal metal joints.

2.8 ACCESSORIES

- A. Fasteners: Same material and finish as flashing metal, with soft neoprene washers.
- B. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over 220 deg F (111 deg C); and complying with physical requirements of ASTM D 226/D 226M for Type I and Type II felts.
- C. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer in accordance with underlayment manufacturer's written instructions.
 1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C) or higher.
 2. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F or lower.
- D. Underlayment: Polyethylene, 6 mil, 0.006 inch thick.
- E. Slip Sheet: Rosin-sized sheathing paper, 3 lb/100 sq. ft. minimum.
- F. Primer Type: Zinc chromate.
- G. Concealed Sealants: Non-curing butyl sealant.
- H. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
- I. Asphalt Roof Cement: ASTM D4586/D4586M, Type I, asbestos-free.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.
- C. Verify compliance with requirements for installation tolerances of substrates.
- D. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- E. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

3.2 INSTALLATION

- 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, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 - 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 - 3. Space cleats not more than 12 inches (300 mm) apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
 - 4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
 - 5. Install sealant tape where indicated.
 - 6. Torch cutting of sheet metal flashing and trim is not permitted.
 - 7. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
 - 1. Coat concealed side of uncoated-aluminum sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
 - 2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet (3 m) with no joints within 24 inches (600 mm) of corner or intersection.
 - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
 - 2. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate
 - 1. Wood blocking or sheathing: not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws. Substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

2. Metal decking: not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
 1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets with solder to width of 1-1/2 inches (38 mm); however, reduce pre-tinning where pre-tinned surface would show in completed Work.
 1. Do not solder metallic-coated steel and aluminum sheet.
 2. Do not use torches for soldering.
 3. Heat surfaces to receive solder, and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
- H. Rivets: Rivet joints in uncoated aluminum where necessary for strength and not exposed to view.
- I. See Section _____ for reglet installation requirements.
- J. Secure gutters and downspouts in place with concealed fasteners.
- K. Slope gutters 1/4 inch per 10 feet, minimum.
- L. Set splash pans under downspouts.

3.3 ROOF-DRAINAGE SYSTEM INSTALLATION

- A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in elastomeric sealant compatible with the substrate.
- C. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated. Lap joints minimum of 4 inches (100 mm) in direction of water flow.

3.4 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, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch (75-mm) centers.
- C. Copings: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated.
 1. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at [24-inch (600-mm)] [16-inch (400-mm)] centers.

2. Anchor interior leg of coping with washers and screw fasteners through slotted holes at [24-inch (600-mm)] centers.
- D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches (100 mm) over base flashing. Install stainless-steel draw band and tighten.
- E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches (100 mm) over base flashing. Lap counterflashing joints minimum of 4 inches (100 mm). Secure in waterproof manner by means of snap-in installation and sealant or lead wedges and sealant; interlocking folded seam or blind rivets and sealant unless otherwise indicated.
- F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.5 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.
- B. Overhead-Piping Safety Pans: Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings. Pipe and install drain line to plumbing waste or drainage system.

3.6 TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
- B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.7 3.8 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 sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.
- 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 72 00
ROOF ACCESSORIES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Roof curbs.
- B. Equipment rails and supports.
- C. Roof penetrations mounting curbs.
- D. Roof hatches.
- E. Factory-fabricated ladder safety posts.
- F. Non-penetrating pedestals.
- G. Rooftop stairs (ship ladder).
- H. Preformed flashing sleeves.

1.2 RELATED REQUIREMENTS

- A. Section 05 50 00 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
- B. Section 07 62 00 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

1.4 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used.
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Maintenance requirements.
- C. Shop Drawings: Submit detailed layout developed for this project and provide dimensioned location and number for each type of roof accessory.
 - 1. Non-penetrating Rooftop Supports: Submit design calculations for loadings and spacings.

- D. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items.
- E. Warranty Documentation:
 - 1. Submit manufacturer warranty.
 - 2. Ensure that forms have been completed in Owner's name and registered with manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 5-year manufacturer warranty guaranteeing products to be free from defects in material and workmanship. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.1 ROOF CURBS

- A. Roof Curbs Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AES Industries Inc: www.aescurb.com/#sle.
 - 2. The Pate Company: www.patecurbs.com/#sle.
 - 3. LMCurbs: www.lmcurbs.com/#sle.
- B. Roof Curbs Mounting Assemblies: Factory fabricated hollow sheet metal construction, internally reinforced, and capable of supporting superimposed live and dead loads and designated equipment load with fully mitered and sealed corner joints welded or mechanically fastened, and integral counterflashing with top and edges formed to shed water.
 - 1. Roof Curb Mounting Substrate: Curb substrate consists of corrugated metal roof deck with insulation.
 - 2. Sheet Metal Material:
 - a. Galvanized Steel: Hot-dip zinc coated steel sheet complying with ASTM A653/A653M, SS Grade 33; G60 coating designation; 18 gauge, 0.048 inch thick.
 - 1) Finish: Mill phosphatized.
 - 3. Provide layouts and configurations indicated on drawings.
- C. Equipment Support: Straight curbs on each side of equipment, with top of curbs parallel with metal roofing system and each other for equipment mounting.
 - 1. Height Above Metal Roofing System: 5 inches, minimum.
- D. Pipe, Duct, or Conduit Mounting Curbs: Vertical posts, minimum 8 inches square unless otherwise indicated.

2.2 ROOF HATCHES

- A. Roof Hatches: Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.

B. Roof Hatch Manufacturers:

1. Bilco Company; Type L (service stair size) and Type F (equipment access, 4 ft square):
www.bilco.com/#sle.

C. Roof Hatch Type L

1. Basis-of-Design Product: Provide Type L-50TB Roof Hatch by The BILCO Company, P.O. Box 1203, New Haven, CT 06505, 1-800-366-6530, Fax: 1-203-535-1582, Web: www.BILCO.com.
2. Furnish and install where indicated on plans metal roof hatch Type L-50TB, size width: 30" (762mm) x length: 96" (2438mm). Length denotes hinge side. The roof hatch shall be single leaf. The roof hatch shall be pre-assembled from the manufacturer.
3. Performance characteristics:
 - a. Cover and curb shall be thermally broken to prevent heat transfer between interior and exterior surfaces.
 - b. Cover shall be reinforced to support a minimum live load of 40 psf (195kg/m²) with a maximum deflection of 1/150th of the span or 20 psf (97kg/m²) wind uplift.
 - c. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
 - d. Operation of the cover shall not be affected by temperature.
 - e. Entire hatch shall be weather tight with fully welded corner joints on cover and curb.
4. Cover: Shall be 11 gauge (2.3mm) aluminum with a 5" (127mm) beaded flange with formed reinforcing members. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation. Cover shall have a heavy extruded EPDM rubber gasket bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.
5. Cover insulation: Shall be 3" (75mm) thick polyisocyanurate with an R-value = 20.3 (U=0.279 W/m²K), fully covered and protected by an 18 gauge (1mm) aluminum liner.
6. Curb: Shall be 12" (305mm) in height and of 11 gauge (2.3mm) aluminum. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation. The curb shall be formed with a 5-1/2" (140mm) flange with 7/16" (11mm) holes provided for securing to the roof deck. The curb shall be equipped with an integral metal capflashing of the same gauge and material as the curb, fully welded at the corners, that features the Bil-Clip® flashing system, including stamped tabs, 6" (153mm) on center, to be bent inward to hold single ply roofing membrane securely in place.
7. Curb insulation: Shall be 3" (75mm) thick polyisocyanurate with an R-value = 20.3 (U=0.279 W/m²K).
8. Lifting mechanisms: Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe welded to the curb assembly.
9. Hardware
 - a. Heavy stainless steel pintle hinges shall be provided
 - b. Cover shall be equipped with an enclosed two-point spring latch with interior and exterior turn handles.
 - c. Roof hatch shall be equipped with interior and exterior padlock hasps.
 - d. The latch strike shall be a stamped component bolted to the curb assembly.

- e. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a 1" (25mm) diameter red vinyl grip handle to permit easy release for closing.
 - f. All hardware shall be zinc plated and chromate sealed. [For installation in highly corrosive environments or when prolonged exposure to hot water or steam is anticipated, specify Type 316 stainless steel hardware].
 - g. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.
10. Finishes: Factory finish shall be mill finish aluminum.
- D. Roof Hatch Type F
- 1. Basis-of-Design Product: Provide Type F-50TB Roof Hatch by The BILCO Company, P.O. Box 1203, New Haven, CT 06505, 1-800-366-6530, Fax: 1-203-535-1582, Web: www.BILCO.com.
 - 2. Furnish and install where indicated on plans metal roof hatch Type F-50TB, size width: 48" (1219mm) x length: 48" (1219mm). Length denotes hinge side. The roof hatch shall be single leaf. The roof hatch shall be pre-assembled from the manufacturer.
 - 3. Performance characteristics:
 - a. Cover and curb shall be thermally broken to prevent heat transfer between interior and exterior surfaces.
 - b. Cover shall be reinforced to support a minimum live load of 40 psf (195kg/m²) with a maximum deflection of 1/150th of the span or 20 psf (97kg/m²) wind uplift.
 - c. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
 - d. Operation of the cover shall not be affected by temperature.
 - e. Entire hatch shall be weather tight with fully welded corner joints on cover and curb.
 - 4. Cover: Shall be 11 gauge (2.3mm) aluminum with a 5" (127mm) beaded flange with formed reinforcing members. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation. Cover shall have a heavy extruded EPDM rubber gasket bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.
 - 5. Cover insulation: Shall be 3" (75mm) thick polyisocyanurate with an R-value = 20.3 (U=0.279 W/m²K), fully covered and protected by an 18 gauge (1mm) aluminum liner.
 - 6. Curb: Shall be 12" (305mm) in height and of 11 gauge (2.3mm) aluminum. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation. The curb shall be formed with a 5-1/2" (140mm) flange with 7/16" (11mm) holes provided for securing to the roof deck. The curb shall be equipped with an integral metal capflashing of the same gauge and material as the curb, fully welded at the corners, that features the Bil-Clip® flashing system, including stamped tabs, 6" (153mm) on center, to be bent inward to hold single ply roofing membrane securely in place.
 - 7. Curb insulation: Shall be 3" (75mm) thick polyisocyanurate with an R-value = 20.3 (U=0.279 W/m²K).
 - 8. Lifting mechanisms: Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe welded to the curb assembly.
 - 9. Hardware
 - a. Heavy stainless steel pintle hinges shall be provided

- b. Cover shall be equipped with a spring latch with interior and exterior turn handles
 - c. Roof hatch shall be equipped with interior and exterior padlock hasps.
 - d. The latch strike shall be a stamped component bolted to the curb assembly.
 - e. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a 1" (25mm) diameter red vinyl grip handle to permit easy release for closing.
 - f. All hardware shall be zinc plated and chromate sealed. [For installation in highly corrosive environments or when prolonged exposure to hot water or steam is anticipated, specify Type 316 stainless steel hardware].
 - g. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.
10. Finishes: Factory finish shall be mill finish aluminum.

2.3 LADDER SAFETY POST

- A. Basis-of-Design Manufacturer: Type LU Ladder Safety Post by The BILCO Company, P.O. Box 1203, New Haven, CT 06505, 1-800-366-6530, Fax: 1-203-535-1582, Web: www.bilco.com. Comply with the following:
- B. Furnish and install where indicated on plans ladder safety post Model LU-1, The ladder safety post shall be pre-assembled from the manufacturer.
- C. Performance characteristics:
 - 1. Tubular post shall lock automatically when fully extended.
 - 2. Safety post shall have controlled upward and downward movement.
 - 3. Release lever shall disengage the post to allow it to be returned to its lowered position.
 - 4. Post shall have adjustable mounting brackets to fit ladder rung spacing up to 14" (356mm) on center and clamp brackets to accommodate ladder rungs up to 1-3/4" (44mm) in diameter.
- D. Post: Shall be manufactured of high strength square tubing. A pull up loop shall be provided at the upper end of the post to facilitate raising the post.
- E. Material of construction: Shall be steel.
- F. Balancing spring: A stainless steel spring balancing mechanism shall be provided to provide smooth, easy, controlled operation when raising and lowering the safety post.
- G. Hardware: All mounting hardware shall be Type 316 stainless steel.
- H. Finishes: Factory finish shall be yellow powder coat steel.

2.4 NON-PENETRATING ROOFTOP SUPPORTS/ASSEMBLIES

- A. Non-Penetrating Rooftop Support/Assemblies: Manufacturer-engineered and factory-fabricated, with pedestal bases that rest on top of roofing membrane, and not requiring any attachment to roof structure and not penetrating roofing assembly.
 - 1. Design Loadings and Configurations: As required by applicable codes.
 - 2. Support Spacing and Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - 3. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - 4. Hardware, Bolts, Nuts, and Washers: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.

2.5 SHIPS LADDER

- A. Prefabricated Modular Metal Stairs: Standardized, modular stair components designed with manufacturer's standard stair angle and height charts. Field assemble with mechanical fasteners only.

1. Material: Aluminum, ASTM B221; 6063 alloy, T52 temper for extrusions and 5052 alloy, H32 temper for sheets.
2. Risers: Open.
3. Treads: Manufacturer's standard diamond plate.
4. Tread width: 24 inches.
5. Tread depth: 4 inches.
6. Rails:
 - a. Rail Finish: Powder coat, safety yellow.
7. Stair Finish: Manufacturer's standard mill finish.

2.6 PREFORMED FLASHING SLEEVES

- A. Exhaust Vent Flashing: Double-walled metal flashing sleeve or boot, insulation filled, with integral deck flange, 12 inches high, with removable metal hood and perforated metal collar.
 1. Metal: Aluminum sheet, 0.063 inch thick.
 2. Diameter: As indicated on Drawings.
 3. Finish: Manufacturer's standard.
- B. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.
 1. Metal: Aluminum sheet, 0.063 inch thick.
 2. Height: 13 inches.
 3. Diameter: As indicated on Drawings.
 4. Finish: Manufacturer's standard.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions, in manner that maintains roofing system weather-tight integrity.
 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 - 1. Coat concealed side of uncoated aluminum or stainless steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 - 2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
 - 3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. Roof Curb Installation: Install each roof curb so top surface is level.
- D. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.
- E. Roof-Hatch Installation:
 - 1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
 - 2. Attach safety railing system to roof-hatch curb.
 - 3. Attach ladder-assist post according to manufacturer's written instructions.
- F. Pipe Support Installation: Comply with MSS SP-58 and MSS SP-89. Install supports and attachments as required to properly support piping. Arrange for grouping of parallel runs of horizontal piping, and support together.
 - 1. Pipes of Various Sizes: Space supports for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
- G. Preformed Flashing-Sleeve and Flashing-Pipe Portal Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane according to roof membrane manufacturer's instructions.
- H. Seal joints with sealant as required by roof accessory manufacturer.

3.4 CLEANING

- A. Clean installed work to like-new condition.

3.5 PROTECTION

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

END OF SECTION 07 72 00

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SECTION 07 92 00
JOINT SEALANTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nonsag gunnable joint sealants.
- B. Self-leveling pourable joint sealants.
- C. Joint backings and accessories.
- D. Joint sealant schedule.

1.2 RELATED REQUIREMENTS

- A. Section 04 20 00 "Unit Masonry" for masonry control and expansion joint fillers and gaskets.
- B. Section 08 80 00 - Glazing;
- C. Section 09 21 16 - Gypsum Board Assemblies: Sealing perimeter joints.
- D. Section 09 30 00 - Tiling: Sealant between tile and plumbing fixtures and at junctions with other materials and changes in plane.

1.3 REFERENCE STANDARDS

- A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer; 2015 (Reapproved 2022).
- B. ASTM C719 - Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle); 2022.
- C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- D. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016 (Reapproved 2023).
- E. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants; 2022.
- F. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants; 2023.
- G. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2022).

1.4 SUBMITTALS

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

- C. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
- D. Samples: For each kind and color of joint sealant required.
- E. 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.
- F. Sample warranty.

1.5 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.6 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide manufacturer warranty for installed sealants and accessories that fail to achieve a watertight seal, exhibit loss of adhesion or cohesion, or do not cure. Complete forms in Owner's name and register with manufacturer.
 - 1. Warranty Period: **Five years** from date of Substantial Completion.
- C. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: **Two years** from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Nonsag Sealants:
 - 1. Adfast USA Inc: www.adfastcorp.com/#sle.
 - 2. Dow: www.dow.com/#sle.
 - 3. Henry Company: www.henry.com/#sle.
 - 4. Sika Corporation: www.usa.sika.com/#sle.
 - 5. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.
 - 6. W.R. Meadows, Inc: www.wrmeadows.com/#sle.
 - 7. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Self-Leveling Sealants:
 - 1. Dow: www.dow.com/#sle.
 - 2. Sika Corporation: www.usa.sika.com/#sle.

3. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.
4. W.R. Meadows, Inc: www.wrmeadows.com/#sle.
5. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 JOINT SEALANT APPLICATIONS

- A. Scope:
 1. Exterior Joints:
 - a. Seal the following joints:
 - 1) Wall expansion and control joints.
 - 2) Joints between doors, windows, and other frames or adjacent construction.
 - 3) Joints between different exposed materials.
 - 4) Other joints as indicated on Drawings.
 2. Interior Joints:
 - a. Seal the following joints:
 - 1) Joints between door frames and window frames and adjacent construction.
 - 2) In wall and ceiling assemblies, gaps at electrical outlets, wiring devices, and piping penetrations.
 - 3) In wall and ceiling assemblies, seal joints between wall assemblies and ceiling assemblies; between wall assemblies and other construction; between ceiling assemblies and other construction.
 - 4) Other joints as indicated on Drawings.
 3. Do Not Seal:
 - a. Intentional weep holes in masonry.
- B. Sound-Rated Assemblies: Walls and ceilings identified as STC-rated, sound-rated, or acoustical.

2.3 JOINT SEALANTS - GENERAL

- A. Sealants and Primers: Provide products having lower volatile organic compound (VOC) content than indicated in SCAQMD 1168.
 1. Architectural sealants shall have a VOC content of **250 g/L** or less.
 2. Sealants and sealant primers for nonporous substrates shall have a VOC content of **250 g/L** or less.
 3. Sealants and sealant primers for nonporous substrates shall have a VOC content of **775 g/L** or less.
- B. 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.

2.4 NONSAG JOINT SEALANTS

- A. Type JS-1 - Joint Sealant Application: Exterior joints in vertical and horizontal nontraffic surfaces, nonstaining.
 1. Joint Locations:
 - a. Construction joints in cast-in-place concrete.
 - b. Control and expansion joints in unit masonry.
 - c. Joints in dimension stone cladding.
 - d. Joints in exterior insulation and finish systems.
 - e. Joints between metal panels.
 - f. Joints between different materials listed above.

- g. Perimeter joints between materials listed above and frames of doors windows and louvers.
 - h. Control and expansion joints in ceilings and other overhead surfaces.
 - i. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Silicone, Type S or M, Grade NS, Uses NT, M, G, A, and O.
 - 3. Movement Capability: Plus and minus 50 percent, minimum.
 - 4. Nonstaining to Porous Stone: Nonstaining to light-colored masonry when tested in accordance with ASTM C1248.
 - 5. Color: To be selected by Architect from manufacturer's custom range.
- B. Type JS-2 - Joint Sealant Application: Interior joints in horizontal traffic surfaces.
 - 1. Joint Locations:
 - a. Joints in cast-in-place concrete slabs.
 - b. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Silicone, Type S or M, Grade NS, Uses T, M, G, A, and O.
 - 3. Movement Capability: Plus and minus 50 percent, minimum.
 - 4. Color: To be selected by Architect from manufacturer's custom range.
- C. Type JS-3 - Joint Sealant Application: Interior joints in vertical and horizontal nontraffic surfaces, nonstaining.
 - 1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Tile control and expansion joints.
 - c. Vertical joints on exposed surfaces of unit masonry concrete walls and partitions.
 - d. Joints on underside of plant-precast structural concrete beams and planks.
 - e. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Silicone, Type S or M, Grade NS, Uses NT, M, G, A, and O.
 - 3. Movement Capability: Plus and minus 50 percent, minimum.
 - 4. Color: To be selected by Architect from manufacturer's custom range.
- D. Type JS-4 - Joint Sealant Application: Interior joints in vertical and horizontal surfaces not subject to significant movement; paintable.
 - 1. Joint Locations:
 - a. Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.
 - b. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Silicone or Ur, Type S or M, Grade NS, Uses NT, M, G, A, and O.
 - 3. Movement Capability: Plus and minus 25 percent, minimum.
 - 4. Color: To be selected by Architect from manufacturer's custom range.
- E. Type JS-5 - Joint Sealant Application: Joints in vertical and horizontal surfaces subject to water immersion.
 - 1. Joint Locations:
 - a. Joints below grade.
 - b. Penetrations through below grade structure.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Urethane, ASTM C920, Type S or M, Grade NS, explicitly approved by manufacturer for continuous water immersion.

- a. Manufacturer's written statement of compatibility with waterproofing and dampproofing materials.
3. Movement Capability: Plus and minus 35 percent, minimum.
4. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
5. Color: Match adjacent finished surfaces.
6. Service Temperature Range: Minus 40 to 180 degrees F.

2.5 SELF-LEVELING JOINT SEALANTS

- A. Type JS-6 - Joint Sealant Application: Exterior joints in horizontal traffic surfaces.
 1. Joint Locations:
 - a. Joints in cast-in-place concrete slabs.
 - b. Joints between different materials listed above.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone, Type S or M, Grade P, Uses T, M, G, A, O.
 3. Movement Capability: Plus 100 percent, minus 50 percent, minimum.
 4. Color: To be selected by Architect from manufacturer's custom range.

2.6 ACCESSORIES

- A. Sealant Backing Materials, General: Nonstaining; materials placed in joint before applying sealants; assists sealant performance and service life by developing optimum sealant profile and preventing three-sided adhesion; type and size recommended by sealant manufacturer for compatibility with sealant, substrate, and application.
- B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- D. Masking Tape: Self-adhesive, nonabsorbent, nonstaining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.
- E. Joint Cleaner: Noncorrosive and nonstaining type, type recommended by sealant manufacturer; compatible with joint forming materials.
- F. Primers: Type recommended by sealant manufacturer to suit application; nonstaining.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.
- C. Verify that backer rods are of the correct size.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

1. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Exterior insulation and finish systems.
2. 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. Remove laitance and form-release agents from concrete.
- D. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
 1. 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.
 2. Masking Tape: Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.
- E. Concrete Floor Joints That Will Be Exposed in Completed Work: Test joint filler in an inconspicuous area to verify that it does not stain or discolor slab.

3.3 INSTALLATION

- A. Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Provide joint sealant installations complying with ASTM C1193.
 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.
- C. Install bond breaker backing tape where backer rod cannot be used.
- D. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- E. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- F. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.
 1. Remove excess sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.
 4. Provide flush joint profile according to Figure 8B in ASTM C 1193.
 5. Provide recessed joint configuration of recess depth according to Figure 8C in ASTM C 1193.

- a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

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

3.5 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.

3.6 PROTECTION

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

END OF SECTION 07 92 00

SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Non-fire-rated hollow metal doors and frames.
- B. Hollow metal frames for wood doors.
- C. Fire-rated hollow metal doors and frames.
- D. Thermally insulated hollow metal doors with frames.
- E. Hollow metal borrowed lites glazing frames.
- F. Accessories, including glazing, louvers, and matching panels.

1.2 RELATED REQUIREMENTS

- A. Section 08 34 73 - Sound Control Door and Window Assemblies.
- B. Section 08 71 00 - Door Hardware.
- C. Section 08 80 00 - Glazing: Glass for doors and borrowed lites.
- D. Section 09 91 13 - Exterior Painting: Field painting.
- E. Section 09 91 23 - Interior Painting: Field painting.

1.3 ABBREVIATIONS AND ACRONYMS

- A. ANSI: American National Standards Institute.
- B. ASCE: American Society of Civil Engineers.
- C. HMMA: Hollow Metal Manufacturers Association.
- D. NAAMM: National Association of Architectural Metal Manufacturers.
- E. NFPA: National Fire Protection Association.
- F. SDI: Steel Door Institute.
- G. UL: Underwriters Laboratories.

1.4 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors; 2022.
- C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2023.
- D. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2020.
- E. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- 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; 2023, with Editorial Revision.
- 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; 2023.
- I. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2020.
- J. ASTM C476 - Standard Specification for Grout for Masonry; 2023.

- K. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.
- L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- M. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C; 2024.
- N. BHMA A156.115 - Hardware Preparation in Steel Doors and Frames; 2016.
- O. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- P. ITS (DIR) - Directory of Listed Products; Current Edition.
- Q. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames; 2002.
- R. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames; 2011.
- S. NAAMM HMMA 840 - Guide Specifications For Receipt, Storage and Installation of Hollow Metal Doors and Frames; 2017.
- T. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames; 2014.
- U. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.
- V. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.
- W. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames; 2023.
- X. UL (DIR) - Online Certifications Directory; Current Edition.
- Y. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.
 - 1. Elevations of each door design.
 - 2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 4. Locations of reinforcement and preparations for hardware.
 - 5. Details of each different wall opening condition.
 - 6. Details of anchorages, joints, field splices, and connections.
 - 7. Details of accessories.
 - 8. Details of moldings, removable stops, and glazing.
 - 9. Details of conduit and preparations for power, signal, and control systems.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.
 - 1. Do not use non-vented plastic.
- C. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

- D. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4 inch high wood blocking. Do not store in a manner that traps excess humidity.
 - 1. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

1.7 PROJECT CONDITIONS

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

1.8 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Requirements for Hollow Metal Doors and Frames:
 - 1. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
 - 2. Accessibility: Comply with ICC A117.1 and ADA Standards.
 - 3. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.
 - a. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A153/A153M, Class B.
 - 4. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.
 - 5. Grout: ASTM C476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C143/C143M.
 - 6. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6 to 12-lb/cu. ft. density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.
 - 7. Exterior Door Top Closures: Flush end closure channel, with top and door faces aligned.
 - 8. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturer's standard.
 - 9. 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.
 - 10. Zinc Coating for Typical Interior and/or Exterior Locations: Provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvanized) by the hot-dip process in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness, unless noted otherwise for specific hollow metal doors and frames.

- a. Based on SDI Standards: Provide at least A40/ZF120 (galvannealed) when necessary, coating not required for typical interior door applications, and at least A60/ZF180 (galvannealed) for corrosive locations.
- B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.2 HOLLOW METAL DOORS

- A. Door Finish: Factory primed and field finished.
- B. Exterior Doors: Thermally insulated.
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 3 - Extra Heavy-duty.
 - b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 2 - Seamless.
 - d. Door Face Metal Thickness: 16 gauge, 0.053 inch, minimum.
 - e. Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.
 - 2. Door Core Material: Polyurethane, 1.8 lbs/cu ft minimum density.
 - a. Foam Plastic Insulation: Manufacturer's standard board insulation with maximum flame spread index (FSI) of 75, and maximum smoke developed index (SDI) of 450 in accordance with ASTM E84, and completely enclosed within interior of door.
 - 3. Door Thermal Resistance: R-Value of 8.7, minimum, for installed thickness of polyurethane.
 - 4. Door Thickness: 1-3/4 inches, nominal.
 - 5. Door Face Sheets: Flush.
 - 6. Weatherstripping: Refer to Section 08 71 00.
- C. Interior Doors, Non-Fire-Rated:
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 2 - Heavy-duty.
 - b. Physical Performance Level B, 500,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 2 - Seamless.
 - d. Door Face Metal Thickness: 16 gauge, 0.053 inch, minimum.
 - e. Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.
 - 2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
 - 3. Door Thickness: 1-3/4 inches, nominal.
 - 4. Door Face Sheets: Flush.
- D. Fire-Rated Doors:
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 2 - Heavy-duty.
 - b. Physical Performance Level B, 500,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 2 - Seamless.
 - d. Door Face Metal Thickness: 16 gauge, 0.053 inch, minimum.
 - e. Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.

2. Fire Rating: As indicated on Door Schedule, tested in accordance with UL 10C and NFPA 252 ("positive pressure fire tests").
3. Provide units listed and labeled by UL (DIR) or ITS (DIR).
 - a. Attach fire rating label to each fire rated unit.
4. Door Thickness: 1-3/4 inches, nominal.
5. Door Face Sheets: Flush.
- E. Sound Control Door Assemblies: Refer to Section 08 34 73.
- F. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

2.3 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. Frame Finish: Factory primed and field finished.
- C. Exterior Door Frames: Full profile/continuously welded type.
 1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
 2. Frame Metal Thickness: 14 gauge, 0.067 inch, minimum.
 3. Weatherstripping: Separate, see Section 08 71 00.
- D. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
 1. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.
- E. Door Frames, Fire-Rated: _____.
 1. Fire Rating: Same as door, labeled.
 2. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.
- F. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.
- G. Borrowed Lites Glazing Frames: Construction and face dimensions to match door frames, and as indicated on drawings.
- H. Transom Bars: Fixed, of profile same as jamb and head.
- I. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units.
- J. Frames Wider than 48 inches: Reinforce with steel channel fitted tightly into frame head, flush with top.
- K. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

2.4 FRAME ANCHORS

- A. Jamb Anchors:
 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (50 mm) wide by 10 inches (250 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.
 2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (1.0 mm) thick.
 3. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

2.5 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. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.
- C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.

2.6 FABRICATION

- A. Fabricate hollow metal work 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. Hollow Metal Doors:
 - 1. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted.
- 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. Sidelite Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry 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) Two anchors per jamb up to 60 inches (1524 mm) high.
 - 2) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
 - 3) Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.
 - 4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high.
 - 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) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
 - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.
 - 5) Two anchors per head for frames above 42 inches (1066 mm) wide and mounted in metal-stud partitions.
 - c. Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.
 - 4. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - 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.
- D. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.
- E. 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. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
 - 2. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.
 - 3. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 - 4. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.
- F. Hardware Preparation: Factory prepare hollow-metal frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with BHMA A156.115 for preparing hollow-metal frames for hardware.

2.7 FINISHES

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

2.8 ACCESSORIES

- A. Glazing: As specified in Section 08 80 00, factory installed.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify that finished walls are in plane to ensure proper door alignment.
- D. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.

3.3 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

- C. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.
- D. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
- E. At fire-protection-rated openings, install frames according to NFPA 80.
- F. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
- G. Install door silencers in frames before grouting.
- H. Remove temporary braces necessary for installation only after frames have been properly set and secured.
- I. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
- J. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.
- K. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
- L. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
- M. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
- N. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - 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.
 - 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 at floor.
- O. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
 - 1. Non-Fire-Rated Standard Steel Doors:
 - a. Jambs and Head: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
 - b. Between Edges of Pairs of Doors: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
 - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch (9.5 mm).
 - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch (19 mm).
 - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
 - a. Install fire rated units in accordance with NFPA 80.
- P. Coordinate frame anchor placement with wall construction.
- Q. Install door hardware as specified in Section 08 71 00.

3.4 TOLERANCES

- A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.
- B. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.5 ADJUSTING

- A. Adjust for smooth and balanced door movement. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow metal work immediately after installation.
- C. 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.
- D. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- E. Adjust sound control doors so that seals are fully engaged when door is closed.
- F. Test sound control doors for force to close, latch, and unlatch; adjust as necessary in compliance with requirements.

3.6 SCHEDULE

- A. Refer to Door and Frame Schedule on the drawings.

END OF SECTION 08 11 13

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SECTION 08 14 16
FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. Solid-core doors with medium density overlay.
- B. Solid-core doors with wood veneer faces.
- C. Shop priming flush wood door.
- D. Factory finishing flush wood doors
- E. Machining doors for hardware.

1.3 RELATED REQUIREMENTS:

- A. Section 08 80 00 – Glazing: for glass view panels in flush wood doors.
- B. Section 08 70 00 - Door Hardware: for hardware required for flush wood doors.
- C. Section 09 90 00 – Paints, Stains, and Coatings: for field finishing doors.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site. Along with applicable subcontractors, product and/or supplier representatives and testing and inspection agency(ies), the Contractor shall coordinate the date of and invite the Architect and Owner to attend the conference. If needed, insert list of conference participants not mentioned in Section 01 31 00 "Project Management and Coordination."

1.5 SUBMITTALS

- A. Product Data: For each type of door. Include details of core and edge construction, louvers, and trim for openings. Include factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:
 - 1. Dimensions and locations of blocking.
 - 2. Dimensions and locations of mortises and holes for hardware.
 - 3. Dimensions and locations of cutouts.
 - 4. Undercuts.
 - 5. Requirements for veneer matching.
 - 6. Doors to be factory primed and finish requirements.
 - 7. Fire-protection ratings for fire-rated doors.
- C. Samples: Submit two samples of door construction, 12 by 12 inches in size cut from top corner of door.
- D. Samples: Submit two samples of door veneer, 12 by 12 inches in size illustrating wood grain, stain color, and sheen.
 - 1. 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. Contractor to submit finished Samples for each paint color indicated applied to door section sample labeled by paint designation in Division 09 Painting Section

2. Louver blade and frame sections, 6 inches (150 mm) long, for each material and finish specified.
3. Plastic Laminate, 12 inches square, for each color, texture, finish and pattern selected.

1.6 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.
- B. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.
- C. Source Limitations: Obtain flush wood doors from single manufacturer.
- D. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Quality Standards Illustrated."
- E. 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.
- F. Preinstallation Conference: Conduct conference at Project site.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in plastic bags or cardboard cartons.
- C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

1.10 WARRANTY

- A. A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. VT Industries.
 2. Algoma Hardwoods, Inc.
 3. Eggers Industries.

- 4. Marshfield Door Systems, Inc..
- B. Source Limitations: Obtain flush wood doors from single manufacturer.

2.2 DOOR CONSTRUCTION, GENERAL

- A. Certified Wood: Fabricate doors with all wood products produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD- 01-001, "FSC Principles and Criteria for Forest Stewardship."
- B. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain urea formaldehyde.
- C. Structural-Composite-Lumber-Core Doors:
 - 1. Structural Composite Lumber: WDMA I.S.10.
 - a. Screw Withdrawal, Face: 700 lbf.
 - b. Screw Withdrawal, Edge: 400 lbf.
- D. Fire-Protection-Rated Doors: Provide core specified to provide fire-protection rating indicated.
 - 1. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
 - 2. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

2.3 DOORS FOR OPAQUE FINISH

- A. Interior Solid-Core Doors:
 - 1. Grade: Premium.
 - 2. Faces: Medium-density overlay.
 - a. Apply medium-density overlay to directly to high-density hardboard crossbands.
 - b. Hardboard Faces: AHA A135.4, Class 1 (tempered) or Class 2 (standard).
 - c. MDF Faces: ANSI A208.2, Grade 150 or 160.
 - 3. Exposed Vertical and Top Edges: Any closed-grain hardwood.
 - 4. Core: Either glued wood stave or structural composite lumber
 - 5. Construction: Five plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Faces are bonded to core using a hot press.
 - 6. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.

2.4 VENEER-FACED DOORS FOR TRANSPARENT FINISH

- A. Interior Solid-Core Doors:
 - 1. Grade: Premium, with Grade AA faces.
 - 2. Species: White Oak.
 - 3. Cut: Rift.
 - 4. Match between Veneer Leaves: Slip
 - 5. Assembly of Veneer Leaves on Door Faces: Center-balance match.
 - 6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
 - 7. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 20 feet or more.
 - 8. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.

9. Blueprint Match: Where doors are installed adjacent to wood wall panels, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling. Comply with requirements in Section 064023 "Interior Architectural Woodwork."
10. Exposed Vertical and Top Edges: Same species as faces - edge Type A.
11. Core: Either glued wood stave or structural composite lumber.
12. Construction: Five or seven 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.
13. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.

2.5 LOUVERS AND LIGHT FRAMES

- A. Metal Louvers:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Louvers Inc.
 - b. Anemostat; a Mestek company.
 - c. Hiawatha Incorporated.
 - d. L & L Louvers, Inc.
 - e. LL Building Products, Inc.; a division of GAF Materials Corporation.
 - f. Louvers & Dampers, Inc.; a Mestek company.
 - g. McGill Architectural Products.
 2. Blade Type: Vision-proof, inverted V.
 3. Metal and Finish: Extruded aluminum with Class II, clear anodic finish, AA-M12C22A31.

2.6 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 1. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- C. Transom and Side Panels: Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
- D. Openings: Factory cut and trim openings through doors.
 1. Light Openings: Trim openings with moldings of material and profile indicated.
 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."
 3. Louvers: Factory install louvers in prepared openings.

2.7 SHOP PRIMING

- A. Doors for Opaque Finish: Shop prime doors with one coat of wood primer specified in Division 9 Section "Painting." Seal all four edges, edges of cutouts, and mortises with primer.

2.8 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 - 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Factory finish doors that are indicated to receive transparent finish.
- D. Factory finish doors that are indicated to receive opaque finish.
- E. Use only paints and coatings that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- F. Transparent Finish:
 - 1. Grade: Premium.
 - 2. AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" System 10, UV curable, water based.
 - 3. Finish: WDMA TR-4 conversion varnish or WDMA TR-6 catalyzed polyurethane.
 - 4. Staining: Match Architect's sample.
 - 5. Effect: Open-grain finish.
 - 6. Sheen: Satin.
- G. Opaque Finish:
 - 1. Grade: Premium.
 - 2. AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" System 10, UV curable, water based.
 - 3. Finish: WDMA OP-4 conversion varnish or WDMA OP-6 catalyzed polyurethane.
 - 4. Color: Match Architect's sample.
 - 5. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
 - 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 - 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Division 8 Section "Door Hardware".
- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
 - 1. Install fire-rated doors according to NFPA 80.
 - 2. Install smoke- and draft-control doors according to NFPA 105.

- C. Job-Fitted Doors (Where Permitted): Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
 - 1. Clearances: Provide 1/8 inch at heads, jambs, and between pairs of doors. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.
 - a. Comply with NFPA 80 for fire-rated doors.
 - b. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
 - 2. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.
- D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 08 14 16

SECTION 08 31 00
ACCESS DOORS AND PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall-mounted access units.
- B. Ceiling-mounted access units.

1.2 RELATED REQUIREMENTS

- A. Section 08 71 00 - Door Hardware: For mortise or rim cylinder locks and master keying.
- B. Section 09 90 00 - Paints, Stains, and Coatings: Field paint finish.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.
- C. Shop Drawings: Indicate exact position of each access door and/or panel unit.
- D. Product Schedule: For access doors and frames, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation. Use same designations indicated on Drawings.
- E. Ceiling Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including access doors and frames, lighting fixtures, diffusers, grilles, speakers, sprinklers, and special trims are shown and coordinated with each other.

PART 2 PRODUCTS

2.1 ACCESS DOORS AND PANELS ASSEMBLIES

- A. Flush Access Doors with Concealed Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ACUDOR Products, Inc.
 - b. Cendrex Inc.
 - c. J. L. Industries, Inc.; Activar Construction Products Group, Inc.
 - d. Karp Associates, Inc.
 - e. Larsen's Manufacturing Company.
 - f. Milcor; Hart & Cooley, Inc.
 - g. Nystrom, Inc.
 - h. Williams Bros. Corporation of America (The).
 - 2. Description: Face of door flush with frame; with concealed flange for gypsum board and plaster installation and concealed hinge.
 - 3. Location: Wall and Ceiling.
 - 4. Panel Material:
 - a. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage, factory primed.
 - b. Stainless Steel Sheet for Door: Nominal 0.062 inch, 16 gage, ASTM A480/A480M No. 4 finish. At wet locations or as indicated on drawings.
 - 5. Frame Material: Same material and thickness as door.

- a. Drywall Beads: 0.0299-inch (0.76-mm) zinc-coated steel sheet to receive joint compound.
- b. Plaster Beads: 0.0299-inch (0.76-mm) zinc-coated steel with flange of expanded metal lath.
- 6. Size: Coordinate sizes required with Heating, Ventilation, Electrical and Plumbing contractors.
- 7. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.

2.2 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.
- D. Stainless Steel Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, Type 316. Remove tool and die marks and stretch lines, or blend into finish.
- E. Stainless Steel Flat Bars: ASTM A666, Type 316. Remove tool and die marks and stretch lines, or blend into finish.
- F. Aluminum Extrusions: ASTM B221, Alloy 6063.
- G. Aluminum Sheet: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- H. Frame Anchors: Same material as door face.
- I. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.3 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 mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
 - 1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
 - 2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.
- D. Latch and Lock Hardware:
 - 1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
 - 2. Keys: Furnish two keys per lock and key all locks alike.
 - 3. Mortise Cylinder Preparation: Where indicated, prepare door panel to accept cylinder specified in Section 08 71 00 "Door Hardware."

2.4 FINISHES

- A. 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. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
 - 2. Factory Finished: Apply manufacturer's standard baked-enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of 1 mil for topcoat.
 - a. Color: As selected by Architect from full range of industry colors .
- E. Stainless Steel Finishes:
 - 1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
 - 2. Polished Finish: ASTM A480/A480M No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - a. Run grain of directional finishes with long dimension of each piece.
 - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - 3. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M No. 2B.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 INSTALLATION

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

3.4 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 08 31 00

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SECTION 08 34 73
SOUND CONTROL DOOR AND WINDOW ASSEMBLIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Sound control door assemblies.
 - 1. Metal doors and frames.
 - 2. Interior doors and frames, non-fire-rated.
 - 3. Thermally insulated exterior door and frames.
- B. Accessories, including glazing and matching panels.
- C. Sound Control view windows.

1.2 RELATED REQUIREMENTS

- A. Section 08 80 00 - Glazing: Glass for doors and borrowed lites.
- B. Section 09 90 00 - Paint, Stain, and Coatings: Field painting.

1.3 ABBREVIATIONS AND ACRONYMS

- A. HMMA: Hollow Metal Manufacturers Association.
- B. NFPA: National Fire Protection Association.
- C. SDI: Steel Door Institute.
- D. UL: Underwriters Laboratories.

1.4 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ANSI/SDI A250.3 - Test Procedure and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames; 2019.
- C. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames; 2020.
- D. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2023.
- E. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2020.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- 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; 2023, with Editorial Revision.
- 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; 2023.
- I. ASTM E336 - Standard Test Method for Measurement of Airborne Sound Attenuation Between Rooms in Buildings; 2023.
- J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- K. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
- L. ASTM E413 - Classification for Rating Sound Insulation; 2022.

- M. BHMA A156.115 - Hardware Preparation in Steel Doors and Frames; 2016.
- N. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- O. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames; 2002.
- P. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames; 2011.
- Q. NAAMM HMMA 840 - Guide Specifications For Receipt, Storage and Installation of Hollow Metal Doors and Frames; 2017.
- R. NAAMM HMMA 865 - Guide Specifications for Sound Control Hollow Metal Door and Frame Assemblies; 2013.
- S. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames; 2023.
- T. WDMA I.S. 1A - Interior Architectural Wood Flush Doors; 2021, with Errata (2022).

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Independent testing agency accredited as an acoustical laboratory and certified to perform specified field testing.
- B. Maintain at project site copies of reference standards relating to installation of products specified.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect metal doors in compliance with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) and specified requirements.
 - 1. Temporary Frame Spreaders: Provide welded frame jamb spreaders to bottom of metal frame prior to shipping.
- B. Protect wood doors in compliance with WDMA I.S. 1A and specified requirements.
- C. Store wood 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, and break seal on site to permit ventilation.
- D. Remove doors and frames from resilient packaging upon delivery on site and inspect for damage, provide cover over doors for protection until installed, and store in vertical position properly braced with blocking to permit air circulation between components.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Metal Sound Control Door Assemblies:
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. IAC Acoustics; Noise-Lock Acoustic Doors: www.iacacoustics.com/#sle.
 - 2. Krieger Specialty Products; Acoustical Door and Window Wall Assembly: www.kriegerproducts.com.
 - 3. CURRIES Company; an ASSA ABLOY Group company; 757 Series: www.curries.com
 - 4. Noise Barriers; QuietPivot Acoustical Sound Control Door: www.noisebarriers.com/#sle.

5. AMBICO Limited{CH#289286}: www.ambico.com/#sle.
6. Premier Steel Doors and Frames; Sound Transmission Control Doors and Frames:
www.trustpremier.com/#sle.

2.2 REGULATORY REQUIREMENTS

- A. Accessibility: Comply with ICC A117.1 and ADA Standards.
- B. Opening Force of Sound Control Doors, Non-Fire Rated: 5 lbs, maximum, in compliance with ADA Standards.
- C. 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.
- D. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with specified requirements for each type; for instance, a sound control door is also indicated as being an exterior door must comply with requirements specified for sound control doors and exterior doors; where two requirements conflict, comply with most stringent.

2.3 COMPONENTS

- A. Frames for interior use.
- B. Frames for exterior use.
- C. Form frame members straight, and of uniform profile through lengths, as welded units with integral trim, of sizes and profiles indicated.
- D. Stops:
 1. Where integral stops are indicated, form minimum 5/8 inch in depth.
 2. Butt stop joints.
- E. Panels: Same construction, performance, and finish as doors.
- F. Jamb anchors:
 1. Fabricate of same material as frame material; weld anchors inside each jamb for wall anchorage.
 2. Provide anchor types for indicated adjacent wall construction.
- G. Exterior Metal Door Top Closures: Flush end closure channel, with top and door faces aligned.
- H. Door Edge Profile: Manufacturer's standard for application indicated.
- I. Glazed Lights: Factory installed, with removable stops on secure side; sizes and configurations as indicated on drawings.
 1. Style: Manufacturer's standard.
 2. Clear Laminated Acoustical glass shall be furnished in the thickness required to meet the STC ratings. The manufacturer will supply the materials.

2.4 SOUND CONTROL DOOR ASSEMBLIES FOR STC RATING 60 - TYPE 1

- A. Type 1 - STC 60 , Metal Sound Control Interior and Exterior Doors:
- B. Basis-of-Design Product: Provide single and double leaf, "Noise Lock" acoustic door(s) and frame(s) with cam lift hinges and split frames as manufactured by IAC Acoustics, A Division of Sound Seal 401 Airport Road, North Aurora, IL 60542 630-270-1790, or comparable product of other manufacturers approved by the Architect.
- C. MANUFACTURED ASSEMBLIES (NOISE LOCK DOORS)
 1. Door leaf(s) minimum thickness:
 - a. STC 47 thru STC 53 Rating, 2 1/2" (64 mm)
 - b. STC 54 thru STC 61 Rating, 3 1/2" (89 mm)

- c. Door leaf(s) and door stiffeners are to be fabricated from 14 gauge (2 mm) cold rolled, galvanized steel with an A60 coating weight, and filled with 6 lb density, sound absorbing, and damping elements.
2. Frame(s) shall be fabricated from 14 gauge cold rolled, galvanized steel with an A60 coating weight and furnished "split" in two (2) pieces, inside and outside, that are mitered and welded together allowing for easy installation into either existing or new construction openings.
3. Acoustic seals: Doorjamb, meeting stiles of double doors and at the head of the door and frame shall receive self-aligning magnetic, compression seals. Door(s) to be held in closed position by magnetic force of perimeter seals.
4. Acoustic labyrinth shall be created when door is in closed position. Bottom of door leaf shall contain continuous, adjustable, gravity-activated seal that shall compress against the floor as the door is closed. Raised sills and threshold drop seals will not be acceptable.
5. Acoustic Seal assemblies as follows: STC 61 Rating, Magnetic tri-seal type
6. Jamb anchors: Provide jamb anchors as determined by wall construction. Anchors are to be spaced at 12" (305 mm) on center (max) and are to be of a corrosion resistant material.
7. Hardware
 - a. Hinges: IAC, cam-lift, butt-type, hinges, US26D finish (Hinge manufacturer to furnish laboratory test data certifying that hinges of identical design have been cycled a minimum of 125,000 times while supporting a door leaf weighing a minimum of 350 lbs.)
 - 1) Quantities of hinges as follows:
 - a) For door leaf thickness less than or equal to 2 1/2" (64):
 - (1) Two (2) hinges required per leaf for openings up to and including 96" (2438 mm) high
 - (2) Three (3) hinges required per leaf for openings up to and including 120" (3048 mm) high
 - b) For door leaf thickness greater than 2 1/2" (64):
 - (1) Three (3) hinges required per leaf for openings up to and including 96" (2438 mm) high
 - (2) Four (4) hinges required per leaf for openings up to and including 120" (3048 mm) high
 - b. Closers: "LCN" or "Norton", factory installed.
 - c. Pull Handles: 1" (25 mm) diameter x 9" (229 mm) overall length, 3" (76 mm) projection, US28 finish, factory installed.
 - d. Push Plates: 4" (102 mm) wide x 16" (406 mm) high x .050" (1 mm) thick, US32D finish, factory installed.
 - e. Latchsets/Locksets: Provided and installed by door manufacturer. Refer to finish hardware section for manufacturer, type and details.
 - f. Exit Devices: Provided and installed by door manufacturer. Refer to finish hardware section for manufacturer, type and details.
 - g. Flushbolts: "Glynn-Johnson", surface mounted to inactive leaf, top & bottom (used on double leaf doors). Factory installed.
 - h. Coordinators: "Dorma" (used on double leaf doors when both leaves need to be active). Factory installed.
 - i. Hardware Reinforcement

- 1) Hinges: Minimum of 1/4" (6 mm) thick x 2" (51 mm) wide x 7 1/2" (191 mm) lg.
- 2) Frames: Minimum of 3/16" (5 mm) thick for strikes and #11 (3 mm) gauge for closers.
- 3) Doors: Minimum of #11 (3 mm) gauge for lock boxes and closers.
- j. Pre-Hung: Assembly and adjustment of door leaf, frame, acoustic seals, hinges and associated finish hardware shall take place at the factory to insure ease of installation, reliable operation and acoustic performance. The entire manufactured assembly shall be shipped to the job site ready to install and operate.
8. Metal Doors:
 - a. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
 - 1) Zinc Coating for Typical Interior and/or Exterior Locations: Provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvanized) by the hot-dip process in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness, unless noted otherwise for specific hollow metal doors and frames.
9. Wood Doors: White Oak wood veneer to match Architect's sample, shall be applied as a finish, on one or both sides of the door:
 - a. Location: See door schedule for doors requiring wood veneer.
10. Sound Transmission Class (STC) Rating of Sound Control Door Assembly: STC of 60, minimum, calculated in accordance with ASTM E413, and tested in accordance with ASTM E90.
11. Door Thickness: 3-1/2 inches.
12. Door Face Sheets: Flush.
13. Door Finish: Factory finished.
14. Sound Seals: As required by manufacturer to meet indicated sound control ratings.
15. Exterior Doors, Thermally Insulated:
 - a. Door Core Material: Polyurethane, at 1.8 lbs/cu ft minimum density.
 - 1) Foam Plastic Insulation: Manufacturer's standard board insulation with maximum flame spread index (FSI) of 75, and maximum smoke developed index (SDI) of 450 in accordance with ASTM E84, and completely enclosed within interior of door.
 - b. Door Thermal Resistance: R-Value of 8.7, minimum, for installed thickness of polyurethane.
16. Interior Doors, Non-Fire Rated:
 - a. Door Core Material: As required by manufacturer to meet indicated sound control ratings.

2.5 SOUND CONTROL DOOR AND WINDOW WALL ASSEMBLIES FOR STC RATING 50 - TYPE 2

- A. Basis-of-Design Product: Provide Acoustical Door and Window Wall Assembly as manufactured by Krieger Specialty Products, or comparable product of other manufacturers approved by the Architect.

2.6 SOUND CONTROL DOORS

- A. Basis of Design -757 Series as manufactured by CURRIES Company; an ASSA ABLOY Group company or equal.
- B. Description: Provide flush-design sound-control doors, 1-3/4 inches thick, of seamless construction; with manufacturer's standard sound-retardant core as required to provide a minimum rating of STC 41(pair of doors) and STC 46 (single door) or better. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges. Fabricate according to ANSI/NAAMM-HMMA 865.

1. Interior Doors: Fabricate from cold-rolled steel sheet unless otherwise indicated, 18 ga or thicker as required to achieve minimum STC rating.
 2. Top and Bottom Channels: Closed with continuous channels of 16 ga sheet material, spot welded to face sheets not more than 6 inches o.c.
 3. Hardware Reinforcement: 12 ga or 7 ga sheet material depending on hardware.
- C. Materials:
1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
 2. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
 3. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with G60 zinc (galvanized) or A40 zinc-iron-alloy (galvannealed) coating designation.
 4. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers.
- D. Finishes:
1. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
 2. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
 3. Factory-Applied Paint Finish: Manufacturer's standard primer and finish coats, complying with ANSI/SDI A250.3 for performance and acceptance criteria.
 - a. Color and Gloss: As selected by Architect from manufacturer's full range.

2.7 SOUND CONTROL DOOR FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. Description: Fabricate sound-control door frames with corners mitered, reinforced, and continuously welded full depth and width of frame. Fabricate according to ANSI/NAAMM-HMMA 865.
1. Weld frames according to NAAMM-HMMA 820.
 2. Interior Frames: Fabricate from cold-rolled steel sheet unless otherwise indicated, 0.075-inch nominal thickness, or thicker as required to provide STC rating indicated.
 3. Sound-Control Panel Stops: Formed integral with frames, a minimum of 5/8 inch high, unless otherwise indicated.
 4. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 865 of 12 ga sheet material or as required by hardware selected.
 5. Head Reinforcement: Reinforce frames with metallic-coated steel channel or angle stiffener, 0.108-inch nominal thickness, welded to head.
 6. Jamb Anchors: Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.048-inch nominal thickness uncoated steel unless otherwise indicated.
- C. Materials:
1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
 2. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

3. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with G60 zinc (galvanized) or A40 zinc-iron-alloy (galvannealed) coating designation
4. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers.
- D. Finishes:
 1. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
 2. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
 3. Factory-Applied Paint Finish: Manufacturer's standard primer and finish coats, complying with ANSI/SDI A250.3 for performance and acceptance criteria.
 - a. Color and Gloss: As selected by Architect from manufacturer's full range.

2.8 DOOR HARDWARE

- A. Description: Provide manufacturer's standard sound-control system, including head and jamb seals, door bottoms, cam-lift hinges, and thresholds, as required by testing to achieve STC rating indicated.
 1. Compression Seals: One-piece units; consisting of closed-cell sponge neoprene seal held in place by metal retainer; with retainer cover of same material as door frame; attached to door frame with concealed screws.
 2. Magnetic Seals: One-piece units; consisting of closed-cell sponge neoprene seal and resiliently mounted magnet held in place by metal retainer; with retainer cover of same material as door frame; attached to door frame with concealed screws.
 3. Automatic Door Bottoms: Neoprene or silicone gasket, held in place by metal housing, that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.
 - a. Mounting: Mortised into bottom of door as required by testing to achieve STC rating indicated.
 4. Door Bottoms: Neoprene or silicone gasket held in place by metal housing; mortised into bottom edge of door.
 5. Cam-Lift Hinges: Full-mortise template type that raises door 1/2 inch when door is fully open; with hardened pin; fabricated from stainless steel.
 6. Thresholds: Flat, smooth, unfluted type as recommended by manufacturer; fabricated from aluminum.
 - a. Finish: Clear anodic finish.
- B. Other Hardware: Comply with requirements in Section 08 71 00 "Door Hardware."

2.9 FINISHES

- A. Primer, Metal Doors and Frames: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard, in compliance with local VOC requirements.
- B. Metal Door and Frame Finish: Complying with ANSI/SDI A250.3, manufacturer's standard coating.
 1. Color: As selected by Architect from manufacturer's custom range.
- C. Wood Door Finish: Complying with WDMA I.S. 1A, premium grade, manufacturer's standard coating.
 1. Veneer Species: As selected by Architect from manufacturer's custom range.
 - a. Matching: As indicated on drawings.
 - b. Finish: As indicated on drawings.
- D. Bituminous Coating: Asphalt emulsion or other high-build, water-resistant, resilient coating.

2.10 ACCESSORIES

- A. Glazing: As required by the manufacturer to meet the required STC rating, factory installed, and tested to comply with specified sound control ratings as indicated.
- B. Mechanical Fasteners for Concealed Metal-to-Metal Connections: Self-drilling, self-tapping, steel with electroplated zinc finish.
- C. Grout for Frames: Portland cement grout with maximum of 4 inch slump for hand troweling; thinner pumpable grout of higher slump is not permitted.
 - 1. Grouting of frames in drywall/gypsum board construction is not permitted.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.
- B. Coat inside of other frames with bituminous coating to a thickness of 1/16 inch.

3.3 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B. Install prefinished frames after painting and wall finishes are complete.
- C. Coordinate frame anchor placement with wall construction.
- D. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
- E. Comply with recommended practice for hardware placement of doors and frames in accordance with ANSI/SDI A250.6 or NAAMM HMMA 865.
- F. Factory installed glazing, comply with installation requirements; see Section 08 80 00.
- G. Coordinate installation of electrical connections to electrical hardware items.
- H. Touch up damaged factory finishes.

3.4 TOLERANCES

- A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 865.
- B. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.5 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for independent field testing and inspection requirements, and requirements for monitoring quality of specified product installations.
- B. Provide field testing of installed sound control doors by independent laboratory in accordance with ASTM E336 test methods, with results calculated in accordance with ASTM E413 and having acceptable field noise isolation class (NIC) values within 5 dB of laboratory STC rating values.

1. Testing agency to submit testing report to Contractor and Architect within 24 hours after field testing has been completed.
- C. Repair or replace sound control door components that have failed designated field testing, and retest to verify performance complies with specified requirements.

3.6 ADJUSTING

- A. Adjust for smooth and balanced sound control door movement.
- B. Adjust sound control doors so that seals are fully engaged when door is closed.
- C. Adjust sound control doors for force to close, latch, and unlatch; adjust as necessary in compliance with requirements.

3.7 SCHEDULE

- A. Refer to Door and Frame Schedule on drawings.

END OF SECTION 08 34 73

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SECTION 08 43 13
ALUMINUM-FRAMED ENTRANCES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Aluminum-framed, exterior and interior manual-swing entrance doors, with vision glass.

1.2 RELATED REQUIREMENTS

- A. Section 07 92 00 - Joint Sealants: Sealing joints between frames and adjacent construction.
- B. Section 08 44 13 - Glazed Aluminum Curtain Walls.
- C. Section 08 71 00 - Door Hardware: Hardware items other than specified in this section.
- D. Section 08 80 00 - Glazing: Glass and glazing accessories.

1.3 REFERENCE STANDARDS

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.
- B. AAMA 501.1 - Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure; 2017.
- C. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems; 2015.
- D. AAMA 501.4 - Recommended Static Test Method for Evaluating Window Wall, Curtain Wall and Storefront Systems Subjected to Seismic and Wind-Induced Inter-Story Drift; 2018.
- E. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document); 2015.
- F. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2020.
- G. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- H. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- I. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- J. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2023, with Editorial Revision.
- K. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2023.
- L. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- M. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- N. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- O. ASTM B308/B308M - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles; 2020.
- P. ASTM C1184 - Standard Specification for Structural Silicone Sealants; 2023.
- Q. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications; 2018.
- R. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.

- S. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2019.
- T. 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).
- U. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2023).
- V. ASTM E1332 - Standard Classification for Rating Outdoor-Indoor Sound Attenuation; 2022.
- W. BHMA A156.16 - Standard for Auxiliary Hardware; 2023.
- X. BHMA A156.21 - Thresholds; 2019.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.
 - 1. Include design engineer's stamp or seal on shop drawings for attachments and anchors.
 - 2. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
 - 3. 4. Include point-to-point wiring diagrams showing the following:
 - a. Power requirements for each electrically operated door hardware.
 - b. Location and types of switches, signal device, conduit sizes, and number and size of wires.
- D. Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.
- E. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.
- F. Designer's qualification statement.
- G. Installer's qualification statement.

1.5 QUALITY ASSURANCE

- A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State in which the Project is located.
- B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 FIELD CONDITIONS

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

1.8 WARRANTY

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

- B. Manufacturer Warranty: Provide manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units. Complete forms in Owner's name and register with installer.
 - 1. Warranty Period: **Five** years from date of Substantial Completion.
- C. Finish Warranty: Provide manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.
 - 1. Warranty Period: **Ten** years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Aluminum-Framed Storefronts:
 - 1. EFCO Corporation: www.efcocorp.com/#ste
 - 2. Kawneer North America; ____: www.kawneer.com/#sle.
 - 3. Manko Window Systems, Inc; ____: www.mankowindows.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
 - 5. Obtain all components of storefront system, including framing, entrances, and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design aluminum-framed entrances, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. General Performance: Comply with performance requirements specified, as determined by testing of manufacturer's standard aluminum-framed entrances representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Aluminum-framed entrances shall withstand movements of supporting structure indicated on Drawings including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 - 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- C. Wind Loads: **As indicated on Drawings.**
- D. Other Design Loads: **As indicated on Drawings.**
- E. Structural-Test Performance: Test according to ASTM E330/E330M as follows:
 - 1. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
 - 2. Test Durations: 10 seconds.
- F. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding $L/175$ of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.
 2. Deflection Parallel to Glazing Plane: Limited to $L/360$ of clear span or 1/8 inch (3.2 mm), whichever is smaller.
 3. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to two times the length of cantilevered member, divided by 175.
- G. Interstory Drift: Accommodate design displacement of adjacent stories indicated.
1. Design Displacement: As indicated on Drawings.
 2. Test Performance: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.4 at design displacement and 1.5 times the design displacement.
- H. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft..
- I. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft..
 2. Maximum Water Leakage: In accordance with AAMA 501.1. Water leakage does not include water controlled by flashing and gutters or water that is drained to exterior.
- J. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:
1. Thermal Transmittance (U-factor):
 - a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.38 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.
 2. Solar Heat Gain Coefficient (SHGC):
 - a. Fixed Glazing and Framing Areas: Shall have a solar heat gain coefficient as indicated in glazing types.
 3. Air Leakage:
 - a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft. when tested in accordance with ASTM E283/E283M.
 - b. Single Door: Air leakage for the system of not more than 0.5 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft. when tested in accordance with ASTM E283/E283M.
 - c. Pair of Doors: Air leakage for the system of not more than 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft. when tested in accordance with ASTM E283/E283M.
 4. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 35 as determined according to NFRC 500.
- K. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows:
1. Outdoor-Indoor Transmission Class: Minimum 26.
- L. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
1. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.

2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 degrees F.
 - b. Low Exterior Ambient-Air Temperature: 0 degrees F.
 - c. Interior Ambient-Air Temperature: 75 degrees F.
- M. Structural-Sealant Joints:
 1. Designed to carry gravity loads of glazing.
 2. Designed to produce tensile or shear stress of less than 20 psi.
- N. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
 1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
 2. 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.

2.3 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
 1. Framing members for interior applications need not be thermally broken.
- B. Glazing System: Retained mechanically with gaskets on four sides.
- C. Glazing Plane: Front.
- D. Finish: Clear anodic finish.
- E. Fabrication Method: Field-fabricated stick system.
- F. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
- G. Steel Reinforcement: As required by manufacturer.
- H. Glazing: See Section 08 80 00.

2.4 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
 1. Door Construction: **1-3/4 inch overall thickness**, with minimum 0.125 inch thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 2. Door Design: Wide **stile**; 5 nominal width.
 3. Glazing Stops and Gaskets: **Square**, snap-on, extruded-aluminum stops and preformed gaskets.
 - a. Provide nonremovable glazing stops on outside of door.
 4. Finish: Match adjacent storefront framing finish.

2.5 MATERIALS

- A. Extruded Bar, Rod, Profiled, and Tube Aluminum: ASTM B221 (ASTM B221M).
- B. Sheet and Plate Aluminum: ASTM B209/B209M.
- C. Structural Profiles: ASTM B308/B308M.
- D. Steel Reinforcement:
 1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.

2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.
- E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.
- F. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
 1. Color: Black.
- G. Glazing Accessories: See Section 08 80 00.

2.6 FINISHES

- A. Class I Color Anodized Finish: AAMA 611 AA-M10C22A44 Electrolytically deposited colored anodic coating not less than 0.7 mils thick.
- B. Class II Color Anodized Finish: AAMA 611 AA-M12C22A32 Integrally colored anodic coating not less than 0.4 mils thick.
- C. Color: As selected by Architect from manufacturer's custom range, to match Architect's sample.
 1. Color 1: Champagne Anodized per
 2. Color 2: Black Anodized.

2.7 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 087100 "Door Hardware."
- B. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule and entrance door hardware sets indicated in "Entrance Door Hardware Sets" Article for each entrance door to comply with requirements in this Section.
 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.
 3. Opening-Force Requirements:
 - a. 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.
 - b. Accessible Interior Doors: Not more than 5 lbf (22.2 N) to fully open door.
- C. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article. Products are identified by using entrance door hardware designations as follows:
 1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in "Entrance Door Hardware Sets" Article.
 2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.
- D. Continuous-Gear Hinges: Manufacturer's standard with stainless-steel bearings between knuckles, fabricated to full height of door and frame.

- E. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.
- F. Weather Stripping: Manufacturer's standard replaceable components.
 - 1. Compression Type: Made of ASTM D2000, molded neoprene, or ASTM D 2287, molded PVC.
- G. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.
- H. Drip Cap: Provide manufacturer's standard integral drip cap over exterior entrances.
 - 1. Substitute with "142 Rain Drip" by Zero - black anodized (BK), if integral drip cap is not available.
- I. Silencers: BHMA A156.16, Grade 1.
- J. Thresholds: BHMA A156.21, raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch.

2.8 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. 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.
- E. Rigid PVC filler.

2.9 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. 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. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from exterior.
 - 6. 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. 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.
- G. 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.
- H. 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.
- I. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. General:
 - 1. Install wall system in accordance with manufacturer's instructions.
 - 2. Do not install damaged components.
 - 3. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
 - 4. Provide alignment attachments and shims to permanently fasten system to building structure.
 - 5. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
 - 6. Provide thermal isolation where components penetrate or disrupt building insulation.
 - 7. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
 - 8. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
 - 9. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
 - 10. Fit joints to produce hairline joints free of burrs and distortion.
 - 11. Rigidly secure non-movement joints.
 - 12. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 13. Seal perimeter and other joints watertight unless otherwise indicated.
- B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Set continuous sill members and flashing in full sealant bed as specified in Section 079200 "Joint Sealants" to produce weathertight installation.
- D. Install components plumb and true in alignment with established lines and grades.
- E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
- F. Install glazing as specified in Section 088000 "Glazing."
- G. Install weatherseal sealant according to Section 079200 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.
- H. 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.
- I. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.3 TOLERANCES

- A. Erection Tolerances: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
 1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
 2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
 4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.4 FIELD QUALITY CONTROL

- A. Water-Spray Test: Provide water spray quality test of installed storefront components in accordance with AAMA 501.2 during construction process and before installation of interior finishes.
 1. Perform a minimum of two tests in each designated area as directed by Architect.
 2. Conduct tests in each area prior to 35 percent, 50 percent, and 70 percent completion of this work.
- B. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
 1. Perform a minimum of two tests in areas as directed by Architect.

2. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 35 and 70 percent completion.
- C. Repair or replace storefront components that have failed designated field testing, and retest to verify performance complies with specified requirements.

3.5 CLEANING

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

3.6 PROTECTION

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

END OF SECTION 08 43 13

SECTION 08 44 13
GLAZED ALUMINUM CURTAIN WALLS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Aluminum-framed curtain wall, with vision glazing and infill panels.
 - 1. Conventionally glazed, with fiberglass pressure plate for increased thermal performance.
 - 2. Two-sided, structural-sealant-glazed, with fiberglass pressure plate for increased thermal performance.
 - 3. Veneer System, to attach to the existing structure and capture 1" glazing units per Alternate 2.1.
- B. Pre-finished aluminum flashing and trim associated with curtain wall.
- C. Extruded silicone air and vapor barrier transitions installed as part of aluminum curtain wall assemblies to provide an uninterrupted air and vapor barrier between glazed aluminum curtain wall systems and fluid-applied air and vapor barrier.
- D. Firestopping between curtain wall and edge of floor slab.

1.2 RELATED REQUIREMENTS

- A. Section 05 12 00 - Structural Steel Framing: Steel attachment members.
- B. Section 05 50 00 - Metal Fabrications: Steel attachment devices.
- C. Section 07 27 26 - Fluid-applied Membrane Air Barriers: Sealing framing to water-resistive barrier installed on adjacent construction.
- D. Section 07 84 00 - Firestopping: Firestop at system junction with structure.
- E. Section 07 92 00 - Joint Sealants: Sealing joints between frames and adjacent construction.
- F. Section 08 43 13 - Aluminum-Framed Entrances: Entrance framing and doors.
- G. Section 08 64 00 Metal-Framed Glass Floor System.
- H. Section 08 80 00 - Glazing.
- I. Section 12 24 00 - Window Shades: Attachments to framing members.

1.3 REFERENCE STANDARDS

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.
- B. AAMA 501.1 - Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure; 2017.
- C. AAMA 501.4 - Recommended Static Test Method for Evaluating Window Wall, Curtain Wall and Storefront Systems Subjected to Seismic and Wind-Induced Inter-Story Drift; 2018.
- D. AAMA 503 - Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems; 2014.
- E. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document); 2015.
- F. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2020.
- G. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- H. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- I. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

- J. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2023, with Editorial Revision.
- K. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2023.
- L. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- M. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- N. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- O. ASTM B308/B308M - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles; 2020.
- P. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer; 2015 (Reapproved 2022).
- Q. ASTM C793 - Standard Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants; 2023.
- R. ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants; 2018 (Reapproved 2022).
- S. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- T. ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems; 2023.
- U. ASTM C1135 - Standard Test Method for Determining Tensile Adhesion Properties of Structural Sealants; 2019.
- V. ASTM C1184 - Standard Specification for Structural Silicone Sealants; 2023.
- W. ASTM C1249 - Standard Guide for Secondary Seal for Sealed Insulating Glass Units for Structural Sealant Glazing Applications; 2018 (Reapproved 2023).
- X. ASTM C1401 - Standard Guide for Structural Sealant Glazing; 2023.
- Y. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
- Z. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2019.
- AA. 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).
- BB. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2023).
- CC. ASTM E783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors; 2002 (Reapproved 2018).
- DD. ASTM E1105 - 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; 2015 (Reapproved 2023).
- EE. ASTM E1332 - Standard Classification for Rating Outdoor-Indoor Sound Attenuation; 2022.
- FF. NFRC 100 - Procedure for Determining Fenestration Product U-factors; 2023.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.
- B. Preinstallation Meeting: Conduct a preinstallation meeting 10 days before starting work of this section; require attendance by all affected installers.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, internal drainage details, glazing, finishes, and infill.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.
 - 1. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
- D. Shop Drawings: Provide details of proposed structural sealant glazing (SSG) and weather sealant joints indicating dimensions, materials, bite, thicknesses, profile, and support framing.
- E. Fabrication Sample: Submit one sample 12 by 12 inches in size illustrating finished aluminum surface, glazing, and glazing materials.
- F. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
- G. Design Data: Provide framing member structural and physical characteristics and engineering calculations, and identify dimensional limitations; include load calculations at points of attachment to building structure. Signed and sealed by the qualified professional engineer responsible for their preparation.
- H. Structural Sealant Glazing (SSG): Submit product data and calculations showing compliance with performance requirements.
- I. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.
- J. Designer's Qualification Statement.
- K. Installer's Qualification Statement.
- L. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. Designer Qualifications: Design curtain wall and its structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed at the State in which the Project is located. **Submit calculations with shop drawings for concurrent review. Architects and engineers will not proceed with initial review of curtain wall shop drawings without calculations.**
- B. Verify that each component is appropriate for use in structural sealant glazing (SSG) application in regards to at least the following properties: size, shape, dimensions, material, durability, storage conditions, and color.
- C. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience and approved by manufacturer.
- D. Energy Performance Standards: Comply with NFRC 100 for minimum standards of energy performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.

1.7 MOCK-UPS

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Build mockup of typical wall area as shown on Drawings.
 - 2. Testing shall be performed on mockups in accordance with requirements in "Field Quality Control" Article.
 - 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.

1.8 DELIVERY, STORAGE, AND HANDLING

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

1.9 FIELD CONDITIONS

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

1.10 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units. Complete forms in Owner's name and register with installer.
 - 1. Warranty Period: **Five** years from date of Substantial Completion.
- C. Finish Warranty: Provide manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.
 - 1. Warranty Period: **Ten** years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Glazed Aluminum Curtain Walls Manufacturers:
 - 1. EFCO Corporation: www.efcocorp.com/ste#
 - 2. Kawneer North America: www.kawneer.com/#sle.
 - 3. Manko Window Systems, Inc: www.mankowindows.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Obtain all components of curtain-wall system, including framing, entrances, and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design glazed aluminum curtain walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. General Performance: Comply with performance requirements specified, as determined by testing of manufacturer's standard glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Glazed aluminum curtain walls shall withstand movements of supporting structure indicated on Drawings including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 - 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- C. Wind Loads: **As indicated on Drawings.**
- D. Other Design Loads: **As indicated on Drawings.**
- E. Structural-Test Performance: Test according to ASTM E330/E330M as follows:
 - 1. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
 - 2. Test Durations: 10 seconds.
- F. Deflection of Framing Members: At design wind pressure, as follows:
 - 1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
 - 2. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch, whichever is smaller.
 - 3. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to two times the length of cantilevered member, divided by 175.
- G. Interstory Drift: Accommodate design displacement of adjacent stories indicated.
 - 1. Design Displacement: As indicated on Drawings.
 - 2. Test Performance: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.4 at design displacement and 1.5 times the design displacement.
- H. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
 - 1. No evidence of water penetration through fixed glazing and framing areas when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft..
- I. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:
 - 1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft..
 - 2. Maximum Water Leakage: In accordance with AAMA 501.1. Water leakage does not include water controlled by flashing and gutters or water that is drained to exterior.
- J. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:
 - 1. Thermal Transmittance (U-factor):

- a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.38 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.
- 2. Solar Heat Gain Coefficient (SHGC):
 - a. Fixed Glazing and Framing Areas: Shall have a solar heat gain coefficient as indicated in glazing types.
- 3. Air Leakage:
 - a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft. when tested in accordance with ASTM E283/E283M.
- 4. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 35 as determined according to NFRC 500.
- K. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows:
 - 1. Outdoor-Indoor Transmission Class: Minimum 26.
- L. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
 - 1. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.
 - 2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 degrees F.
 - b. Low Exterior Ambient-Air Temperature: 0 degrees F.
 - c. Interior Ambient-Air Temperature: 75 degrees F.
- M. Structural-Sealant Joints:
 - 1. Designed to carry gravity loads of glazing.
 - 2. Designed to produce tensile or shear stress of less than 20 psi.
- N. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
 - 1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
 - 2. 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.

2.3 GLAZED ALUMINUM CURTAIN WALL SYSTEM

- A. Aluminum-Framed Curtain Wall: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Outside glazed, with pressure plate and mullion cover at vertical joints and perimeter mullions, where indicated on drawings.
 - 2. Structural sealant glazing (SSG) adhesive at horizontal joints and vertical corners, where indicated on drawings.
 - 3. Veneer System to retrofit the existing curtainwall system, attach to the existing structure, and to accept 1" insulated glazing units.
 - 4. Construction: Thermally broken.
 - 5. Fabrication Method: Field fabricated stick system.

6. Glazing Method: Field glazed system.
7. Pressure Caps: Manufacturer's thermally improved fiberglass components that mechanically retain glazing unless noted otherwise.
 - a. Material shall be a fiberglass composite with a flexural strength of no less than 82 ksi along the lineal's major axis.
 - b. Material thermal conductivity shall be no more than 2 BTU•in/hr•ft²•F°.
 - c. Include snap-on aluminum trim that conceals fasteners.
8. Provide flush joints and corners, weathersealed, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for imposed loads.
9. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
10. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
11. Steel Reinforcement: As required by manufacturer.

2.4 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
 1. Construction: Thermally broken using ISOBAR.
 2. Glazing System: Retained mechanically with gaskets on four sides.
 3. Glazing Plane: Front.
 4. Structurally Reinforced Members: Extruded aluminum with internal reinforcement of structural steel member.
- B. Glazing: See Section 08 80 00.

2.5 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. 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. Physical and thermal isolation of glazing from framing members.
 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 5. Provisions for field replacement of glazing from exterior.
 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Fabricate components that, when assembled, have the following characteristics:
 1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
 2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.
- E. Factory-Assembled Frame Units:
 1. Rigidly secure non-movement joints.

2. Seal joints watertight unless otherwise indicated.
3. Install glazing to comply with requirements in Division 8 Section "Glazing."
- F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.6 MATERIALS

- A. Extruded Bar, Rod, Profiled, and Tube Aluminum: ASTM B221 (ASTM B221M).
- B. Sheet and Plate Aluminum: ASTM B209/B209M.
- C. Structural Profiles: ASTM B308/B308M.
- D. Steel Reinforcement:
 1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
 2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
 3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.
- E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.
- F. Firestopping: See Section 07 84 00.
- G. Structural Sealant Glazing (SSG) Adhesive: Neutral curing, silicone sealant formulated for SSG applications in compliance with ASTM C1184 and structural glazing industry guidelines, ASTM C1401.
 1. SSG adhesive in compliance with ASTM C920; Type S - Single-component, Grade NS, Class 50, Use NT, G, and A.
 2. Performance: Not less than what is required by loads and conditions indicated on Drawings.
 3. Ultimate Tensile Strength: Minimum of 100 psi as determined by test method ASTM C1135 under the following conditions:
 - a. Exposure to air temperatures of 190 degrees F and minus 20 degrees F.
 - b. Water immersion for seven (7) days, minimum.
 - c. Exposure to weathering for 5,000 hours, minimum.
 4. Hardness: 20 to 60 with Type A-2 durometer in compliance with test method ASTM C661.
 5. Color: Black.
 6. SSG sealant tested for compatibility with glazing accessories in compliance with ASTM C1087, tested for accelerated weathering in compliance with ASTM C793, and in compliance with insulating glass secondary sealant design standards of ASTM C1249.
- H. Weatherseal Sealant: Silicone, with adhesion in compliance with ASTM C794; compatible with glazing accessories.
- I. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
 1. Color: Black.
- J. Glazing Accessories: See Section 08 80 00.

2.7 FINISHES

- A. Class I Color Anodized Finish: AAMA 611 AA-M10C22A44 Electrolytically deposited colored anodic coating not less than 0.7 mils thick.
 1. Color to match Architect's sample:
 - a. Color 1: Champagne Anodized per EFCO.
 - b. Color 2: Black Anodized as noted as dark bronze on the drawings for Craig Hall.

2.8 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. 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.
- E. **Extruded Silicone Air and Vapor Barrier Transitions: Extruded silicone assemblies engineered to provide continuity of air and vapor barrier at perimeter of aluminum framing members. Provide the following assemblies as manufactured by Tremco, Ashland, OH or equal:**
 - 1. Proglaze ETA – System 1, extruded silicone sheet with extruded aluminum adaptor for attachment to aluminum framing members.
 - 2. Proglaze ETA – System 3, extruded silicone sheet stopped into aluminum framing members.
 - 3. Verify compatibility of substrates to receive extruded silicone air and vapor barrier transitions to assure proper adhesion prior to start of work. Coordinate with Contractor.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other related work.
- B. Verify that curtain wall openings and adjoining water-resistive and air barrier seal materials are ready to receive work of this section.
- C. Verify that anchorage devices have been properly installed and located.

3.2 INSTALLATION

- A. Install curtain wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Install firestopping at each floor slab edge.

- H. Structural Sealant Glazing (SSG) Adhesive: Install structural sealant glazing adhesive and weatherseal sealant in accordance with manufacturer's instructions.
- I. Install Extruded Silicone Air and Vapor Barrier Transitions in accordance with manufacturer's recommendations by fully adhering transitions to aluminum framing assemblies and adjacent air and vapor barrier membrane, providing an uninterrupted air and vapor barrier between glazed aluminum curtain wall systems and air and vapor barrier installed by others.
 - 1. Verify compatibility of substrates to receive extruded silicone air and vapor barrier transitions to assure proper adhesion prior to start of work.
- J. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.3 TOLERANCES

- A. A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:
 - 1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
 - 2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
 - 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
 - d. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.4 FIELD QUALITY CONTROL

- A. Provide field testing of installed curtain wall system by AAMA accredited independent laboratory in accordance with AAMA 503 during construction process and before installation of interior finishes.
 - 1. Perform a minimum of two tests in each designated area as directed by Architect.
 - 2. Conduct tests in each area prior to 35 percent and 70 percent completion of this work.
 - 3. Field test for water penetration in accordance with ASTM E1105 with uniform static air pressure difference (Procedure A) not less than 4.18 psf.
 - a. Maximum allowable rate of water penetration in 15-minute test is 0.5 ounce that is not contained in an area with provisions to drain to exterior, or collected on surface of interior horizontal framing member.
 - 4. Field test for air leakage in accordance with ASTM E783 with uniform static air pressure difference of 1.57 psf.
 - a. Maximum allowable rate of air leakage is 0.09 cfm/sq ft.
- B. Structural-Sealant Adhesion: Test structural sealant in accordance with recommendations in ASTM C1401, Destructive Test Method A, "Hand Pull Tab (Destructive)."
 - 1. Test a minimum of four areas on each building facade.
 - 2. Repair installation areas damaged by testing.
- C. Repair or replace curtain wall components that have failed designated field testing, and retest to verify performance complies with specified requirements.

3.5 CLEANING

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

END OF SECTION 08 44 13

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SECTION 08 44 35
FIRE-RATED GLAZED ASSEMBLIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Exterior protective framed glazing assembly.
- B. Interior protective framed glazing assembly.

1.2 RELATED REQUIREMENTS

- A. Section 07 25 00 - Weather Barriers: Sealing framing to water-resistive barrier installed on adjacent construction.
- B. Section 07 84 00 - Firestopping: Firestop at exterior wall assembly junction with structure.
- C. Section 07 92 00 - Joint Sealants: Sealing joints between frames and adjacent construction.

1.3 REFERENCE STANDARDS

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.
- B. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems; 2015.
- C. AAMA 501.4 - Recommended Static Test Method for Evaluating Window Wall, Curtain Wall and Storefront Systems Subjected to Seismic and Wind-Induced Inter-Story Drift; 2018.
- D. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; 2009.
- 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 A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- G. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- H. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- I. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- J. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.
- K. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2019.
- 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 E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2016.
- N. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes; 2023.
- O. ITS (DIR) - Directory of Listed Products; Current Edition.
- P. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.
- Q. UL (DIR) - Online Certifications Directory; Current Edition.
- R. UL 263 - Standard for Fire Tests of Building Construction and Materials; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by each affected installer.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide evidence of compliance with fire performance criteria and manufacturer's published product data on framing components, glazing, anchorage and fasteners, and doors, if any.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.
- D. Samples: Submit samples as follows illustrating each exposed metal finish of interior and exterior project-specific applications.
- E. Design Data: Submit framing member structural and physical characteristics and engineering calculations, and identify dimensional limitations.
- F. Test Reports: Submit results of full-size mock-up testing for criteria other than fire performance. Reports of tests previously performed on the same design are acceptable.
- G. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.
- H. Field Quality Control Submittals: Submit report of field testing for water leakage.
- I. Designer's Qualification Statement.
- J. Installer's Qualification Statement.
- K. Warranty Documentation: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. Designer Qualifications: Perform design under direct supervision of a Professional Structural Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- B. Testing of Full-Size Mock-up: Provide testing of full-size mock-up to ensure compliance with performance requirements of specified system by an independent testing agency for structural, air infiltration, and water penetration criteria.

1.7 MOCK-UPS

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Provide mock-up that includes components of the types specified, and assemble to illustrate complete assembly, including attachments, anchors, and perimeter sealant.

1.8 DELIVERY, STORAGE, AND HANDLING

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

1.9 FIELD CONDITIONS

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

1.10 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.

- C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- D. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.1 FIRE RESISTIVE CURTAINWALL ASSEMBLY

- A. Manufacturers of Framing System:
 - 1. Basis-of-Design Product: Provide GPX® Curtain Wall Framing as manufactured by SAFTI FIRST® Fire Rated Glazing Solutions, or comparable product of other manufacturers approved by the Architect.
- B. Manufacturers of Glazing Material:
 - 1. Basis-of-Design Product: Provide SuperLite® II-XL and SuperLite® II-XL IGU as manufactured by SAFTI FIRST® Fire Rated Glazing Solutions, or comparable product of other manufacturers approved by the Architect.
- C. Fire rated glass and framing must be provided by a single-source, US manufacturer.
- D. Provide factory fabricated, factory finished framing members with glazing and related flashings, anchorage and attachment devices.
 - 1. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" within internal spaces.
 - 2. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
 - 3. Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel and heel bead of glazing compound.
- E. Fire Performance: Provide hourly fire-resistance-rating as indicated; tested as an assembly including glazing in compliance with ASTM E119 or UL 263 and requirements of local authorities having jurisdiction.
 - 1. Acceptable evidence of compliance includes listing by UL (DIR), ITS (DIR), or testing agency acceptable to authorities having jurisdiction.
- F. Structural Performance: Design and size components to withstand the following loading without damage or permanent set.
 - 1. Design Live Loads: Comply with requirements of the following:
 - a. Positive Design Wind Load: ____ lbf/sq ft.
 - b. Negative Design Wind Load: ____ lbf/sq ft.
 - c. Measure performance by testing in accordance with ASTM E330/E330M, using test loads equal to 1.5 times the design wind loads and 10 second duration of maximum pressure.
 - 2. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 - 3. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths or 3/4 inch, whichever is less, under specified design load.
 - 4. Seismic Loads: Design and size components to withstand seismic loads and sway displacement in accordance with the requirements of ASCE 7.

5. Interstory Differential Lateral Movement: Meeting pass/fail criteria of AAMA 501.4 for Use Group I, Standard Occupancy, when tested at design displacement of 0.010 times greater adjacent story height, maximum, and 1.5 times design displacement, through three complete cycles.
6. Wind-Borne-Debris Resistance: Identical full-size glazed assembly without auxiliary protection, tested by independent agency in accordance with ASTM E1996 for Wind Zone 4 - Additional Protection for Large and Small Missile impact and pressure cycling at design wind pressure.
7. Movement: Accommodate the following movement without damage to components or deterioration of seals:
 - a. Expansion and contraction caused by 180 degrees F surface temperature.
 - b. Expansion and contraction caused by cycling temperature range of 170 degrees F over a 12 hour period.
 - c. Movement of wall relative to perimeter framing.
 - d. Deflection of structural support framing, under permanent and dynamic loads.
- G. Water Penetration: No uncontrolled water on indoor face when tested as follows:
 1. Test Pressure Differential: 10 pound-force per square foot.
- H. Air Leakage: 0.06 cfm/sq ft maximum leakage of wall area when tested at 1.57 psf pressure difference in accordance with ASTM E283/E283M.
- I. Thermal Performance:
 1. Condensation Resistance Factor of Framing: 50, minimum, measured in accordance with AAMA 1503.

2.2 FRAMING

- A. Fire resistive curtain wall system rated for 60 to 120 minutes.
- B. Properties:
 1. Frame thickness: 3" Standard. 2-1/2", 4-1/8" and 5" also available.
 2. Internal framing: Internal tube steel framing shall conform to ASTM A501. Formed steel retainers shall be galvanized conforming to ASTM A527.
 3. Insulation: The framing system shall insulate against the effects of fire, smoke and heat transfer from either side. The perimeter of the framing system to the rough opening shall be firmly packed with mineral wool fire stop insulation or appropriately rated intumescent sealant.
 4. Fasteners: Type recommended by manufacturer. No exposed fasteners allowed.
 5. Glazing accessories: The glazing material perimeter shall be separated from the perimeter framing system with approved glazing tape. The SuperLite™ glazing panel may be caulked continuously around the edge to the tube steel frame utilizing neutral cure silicone. Silicone setting blocks recommended.
 6. 60-90 minute Temperature Rise Doors: GPX® Architectural Series Doors and GPX® Builders Series Temperature Rise Doors by SAFTI FIRST® can be used with this system.
 7. SAFTI FIRST listing allows for doors by others.

2.3 GLASS

- A. Assemblies shall be glazed with SuperLite® glazing products. If assembly is required to meet ASTM E 119, SuperLite® II-XL will be used.
- B. Properties:
 1. Individual Lites shall be permanently identified with a listing mark.

2. 2. Glazing material installed in "Hazardous Locations" (subject to human impact) shall be certified to meet the applicable requirements for fire rated assemblies referenced in ANSI Z97.1 Standard for Safety Glazing Materials Used In Buildings and/or CPSC 16 CFR 1201 Safety Standard for Architectural Glazing Materials.
3. 3. Temperature rise on the unexposed side of glazing material shall be limited to 250 degrees Fahrenheit when required.
4. 4. Visible Transmittance:
 - a. SuperLite® II-XL 45 Starphire® 0.883
 - b. SuperLite® II-XL 90 0.853
 - c. SuperLite® II-XL 90 Starphire® 0.875
5. STC/OITC: Varies by glazing type. Must meet:
 - a. SuperLite® II-XL 60 & SuperLite® II-XL 60 Starphire® STC 43/OITC 39
 - b. SuperLite® II-XL 120 & SuperLite® II-XL 120 Starphire® STC 44/OITC 40
6. Pressure glazing is acceptable.
- C. Logo: Each piece of fire rated glazing shall be labeled with a permanent logo.

2.4 COMPONENTS

- A. Framing Members: Formed steel structural members with aluminum cladding and non-combustible thermally-resistive material as required for fire rating.
 1. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 2. Glazing Stops: Flush.

2.5 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Sheet Aluminum: ASTM B209/B209M.
- C. Structural Steel Sections: ASTM A36/A36M; galvanized in accordance with requirements of ASTM A123/A123M.
- D. Firestopping: See Section 07 84 00.
- E. Sealants: See Section 07 92 00 for additional information.
- F. Glazing Gaskets: Type to suit application to achieve fire-rating, weather, moisture, and air infiltration requirements.
- G. Touch-Up Primer for Galvanized Steel Surfaces: SSPC-Paint 20, zinc rich.

2.6 FINISHES

- A. Finishing: Apply factory finish to surfaces that will be exposed in completed assemblies.
 1. Touch-up surfaces cut during fabrication so that no natural metal surfaces are visible in completed assemblies, including joint edges.
- B. Aluminum Finish: Class I color anodized.
 1. Apply factory finish to surfaces that will be exposed in completed assemblies.
 2. Touch-up surfaces cut during fabrication so that no natural aluminum metal surfaces are visible in completed assemblies, including joint edges.
 3. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.

- C. Color: As indicated on the drawings and to match Architect's sample.
 - 1. Color 1: Black Anodized as noted as dark bronze on the drawings for Craig Hall.
 - 2. Color 2:

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify that wall openings and adjoining water-resistive barrier materials are ready to receive work of this section; see Section 07 25 00 for additional information.
- C. Verify that anchorage devices have been properly installed and located.

3.2 INSTALLATION

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

3.3 TOLERANCES

- A. Maximum Variation from Plumb: 1/16 inch every 3 feet non-cumulative or 1/2 inch per 100 ft, whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.
- C. Sealant Space Between Mullions and Adjacent Construction: Maximum of 3/4 inch and minimum of 1/4 inch.

3.4 FIELD QUALITY CONTROL

- A. Exterior Walls: Test installed wall for water leakage in accordance with AAMA 501.2 hose test.
- B. Replace components that have failed field testing and retest until performance is satisfactory.

3.5 ADJUSTING

- A. Adjust doors for smooth operation.

3.6 CLEANING

- A. Remove protective material from pre-finished surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

3.7 PROTECTION

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

END OF SECTION 08 44 35

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SECTION 08 64 00
METAL-FRAMED GLASS FLOOR SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Metal-framed non-rated glass floor system.

1.2 RELATED REQUIREMENTS

- A. Section 05 12 00 - Structural Steel: for steel framing and supports that will remain exposed to view.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal-framed glass floor system.
- B. Shop Drawings: For metal-framed glass floor systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Include details of provisions for assembly expansion and contraction.
 - 2. Include full-size isometric details of the following:
 - a. Joinery including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
- 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 framing intersection of assemblies, made from 12-inch (305-mm) lengths of full-size components and showing details of the following:
 - 1. Joinery including concealed welds.
 - 2. Anchorage.
 - 3. Expansion provisions.
 - 4. Glazing.
- F. Delegated-Design Submittal: For metal-framed glass floor system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Engineer to be licensed in the Commonwealth of Pennsylvania.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and Testing Agency.
- B. Welding certificates.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for metal-framed glass floor system.
- D. Field quality-control reports.
- E. Warranties: Sample of special warranties.
- F. Closeout Submittals: Provide manufacturer's maintenance instructions that include recommendations for periodic cleaning and maintenance of all components.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with minimum documented experience of five completed projects in the past 10 years.
- B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of metal-framed skylights required for this Project.
 - 1. Installer to be company specializing in performing work of this section with minimum documented experience of five completed projects in the past 10 years, and approved by manufacturer.
- C. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
- D. Product Options: Information on Drawings and in Specifications establishes requirements for glass floor system's 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 testing conducted by an independent testing agency and in-service performance.
 - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
- F. Provide a metal-framed glass floor system that complies with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard assemblies by a qualified independent testing agency.
- G. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Build mockup of typical metal-framed glass floor system as directed by Architect.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- H. Preinstallation Conference: Conduct conference at Project site.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal-framed glass floor systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration caused by thermal movements.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Adhesive or cohesive sealant failures.
 - e. Water leakage.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Lite Floor glass floor system by Greenlite Glass Systems Inc., other pre-approved comparable product.
 - 1. Greenlite Glass Systems, Inc. 2495 Davies Avenue, Unit 55 Port Coquitlam, BC
 - a. Canada V3C 0B2 Ph: 778.285.8530. E-Mail: info@greenliteglass.com Web: www.greenliteglass.com

2.2 PERFORMANCE REQUIREMENTS

- A. General: Metal-framed skylights shall withstand the effects of the following without failure due to defective manufacture, fabrication, installation, or other defects in construction:
 - 1. Structural loads.
 - 2. Thermal movements.
 - 3. Movements of supporting structure.
 - 4. Dimensional tolerances of support system and other adjacent construction.
 - 5. Failure includes, but is not limited to, 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.
- B. Delegated Design: Design metal-framed skylights, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Structural Loads: Design glass floor system assemblies and attachments to resist the following loads:
 - 1. Floor Live and dead loads with L/500 of span maximum deflection.
 - a. Live Loads: 100 psf (4.8 kPa) uniform load and concentrated load of 2 kips (14.4 kPa).
 - b. Dead Loads: Actual weight of materials incorporated into Work.
 - 1) Seismic Loads: As calculated in accordance with applicable code.
- D. Thermal Movements: Provide metal-framed glass floor system that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.3 METAL FRAMED GLASS FLOOR WINDOWS

- A. System Description:
 - 1. Steel support framing requires four-sided steel support as primary and secondary support. Steel support is mild steel rolled hollow sections. All steel components supplied with glass floor system shall be primed for field painting.
 - a. Where steel will be inaccessible, yet remains visible, after installation, steel shall be finish painted before being concealed.
 - 2. Glazed Floor Panel System: Glass panels are laminated structural glass suitable for exterior non-rated system applications.
- B. Double Glazed Panel System, Glass Type IG5: Monolithic laminated glass exterior panels.

1. Glass Floor: Non-rated and Fritted.
2. Panel Size: Glass panels up to:
 - a. 1000 mm by 2000 mm.
3. Structural Glass:
 - a. Glass construction: Glass shall be LITEFLOOR-R monolithic laminated structural glass comprised of three layers of heat strengthened glass laminated together using two layers of 0.76 mm or 1.52 mm polyvinyl butyrate, as manufactured by Saint-Gobain Eckelt & Co or equivalent, and as indicated below. Transparent, translucent, or colored interlayer options to be chosen by Architect from standard range.
 - b. Glass thickness: Nominally 33 mm thick comprising 3 by 10 mm heat strengthened sheets laminated together, or 1 by 6 mm heat strengthened top sheet glass with 2 by 12 mm lower sheets subject to final design parameters.
 - c. Surface Finish: Slip-resistant Frit Top surface of uppermost sheet to have approximately 30 to 50 percent coverage, as determined by project and architectural requirements. Eckelt Litefloor anti-slip ceramic frit in standard pattern or slip-resistant acid-etched top surface Eckelt LITEFLOOR EXT range of patterned acid-etch glass. Slip resistance co-efficient will be determined in accordance with ASTM F 1679.
 - d. Pattern & Color of Frit as selected by architect from full range of manufacturer's standard and premium colors and patterns.
 - e. Glass composition shall be as follows:
 - 1) Top: 10 mm LITEFLOOR R Heat Strengthened (Slip resistant # 1 surface from Standard range)
 - 2) Interlayer: 1.52 mm Clear PVB
 - 3) Middle: 10 mm Planidur HS
 - 4) Interlayer: 1.52 mm Clear PVB
 - 5) Bottom: 10 mm Planidur HS
 - 6) Edge: FG Polished / Fine ground
 - 7) Total Thickness: 33.04 mm overall thickness (+/- 1.5mm)
 - 8) Load Unified: 4.80 kN/ sq.m (100 psf) Load Concentrat-
 - 9) Load Concentrated: n/a kN over 100 x100 mm
4. Steel Support Beam Assembly: Lite Frame consists of the load transfer steel support system.
5. Assembly:
 - a. Glass supported on steel frame shall deflect no more than L/500 under the specified loading. Minimum edge support for the glass panels is 20 to 30 mm.
 - b. Sealant Seals between panel and edge to be constructed using two-part polysulphide sealant in standard color as specified in Section 07900.
 - c. Bedding Strip: Bedding strip between glass and supporting steelwork to be 60 shore hardness continuous silicone strip in standard color. Minimum bedding thickness shall be 5 mm.
6. Test Certification: Fire performance of load-bearing glass floor/ceiling assembly has been tested in accordance with ASTM E 119, "Standard test methods for fire tests of building construction and materials".

2.4 FABRICATION

- A. Fit and shop assemble in largest practical sections, for delivery to site and field bolted assembly.

- B. Fabricate components with joints tightly fitted and secured.
- C. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- D. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- E. Prepare steel component surfaces in accordance with SSPC SP 6.
- F. Shop prime and paint steel members. Do not prime surfaces that will be in contact with concrete, or high strength bolted.
 - 1. Finish paint all framing in field after fabrication, unless otherwise indicated.
 - 2. Color top coat to be provided as selected by the Architect.
- G. Supply steelwork to site with primer coat only. Final decorative finish coat to be applied on site after installation of steelwork is completed.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Verify field measurements are as shown on shop drawings.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects.
- C. Allow for erection loads, and for sufficient temporary bracing to maintain platform safe, plumb, and in alignment until completion of erection and installation of permanent bracing.

END OF SECTION 08 64 00

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**SECTION 08 71 00
DOOR HARDWARE**

PART 1 GENERAL

1.1 SECTIONS INCLUDES

- A. Hardware for aluminum and hollow metal doors.
- B. Hardware for aluminum and hollow metal doors.
- C. Thresholds.
- D. Weatherstripping and gasketing.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Details of electrified door hardware.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Other Action Submittals:
 - 1. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - a. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
 - b. Content: Include the following information:
 - 1) Identification number, location, hand, fire rating, size, and material of each door and frame.
 - 2) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - 3) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - 4) Description of electrified door hardware sequences of operation and interfaces with other building control systems.
 - 2. Keying Schedule: Prepared by owner per keying conference.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
- B. Source Limitations: Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.
- C. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- D. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

- E. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22.2 N).
 - 2. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
 - b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 - 3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
 - 4. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.
- F. Keying Conference: Conduct conference at Owner's designated site to coordinate Owner's keying requirements. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
 - 1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - 2. Preliminary key system schematic diagram.
 - 3. Requirements for key control system.
 - 4. Requirements for access control.

1.4 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. 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. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.5 REFERENCE STANDARDS

- A. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.
- B. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

PART 2 PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.

1. 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. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:
 1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Schedule" Article.
 2. References to BHMA Designations: Provide products complying with these designations and requirements for description, quality, and function.
 3. Basis of Design Products: Where Specifications name a product, or refer to a scheduled product 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. Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
 - a. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents, and that it will produce the indicated results, and that it is compatible with other portions of the Work.
 - b. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements.
 - c. Evidence that proposed product provides specified warranty.
 - d. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 - e. Samples, if requested.
 4. Product, Manufacturer: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements. Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
 5. Owner's Standard: Where Specifications refer to a product or manufacturer as an owner standard, substitutions are not allowed.

2.2 HINGES

- A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.
- B. Continuous Hinges: BHMA A156.26; minimum 0.120-inch- (3.0-mm-) thick, hinge leaves with minimum overall width of 4 inches (102 mm); fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.
- C. Continuous, Gear-Type Hinges: 6063-T6 Extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.
 1. On fire-rated doors, provide aluminum geared continuous hinges that are classified for use on rated doors by a testing agency acceptable to the authority having jurisdiction.

2. Provide aluminum geared continuous hinges with factory fabricated cut outs for electrified power transfer where specified.
- D. Basis-of-Design Products: Subject to compliance with requirements, provide scheduled product manufactured by IVES Hardware; Allegion, PLC, (IVE) or a comparable product by:
 1. Hager (HAG).
 2. McKinney (MCK).

2.3 MECHANICAL LOCKS AND LATCHES

- A. Mortise Locks: BHMA A156.2; Grade 1; Series 1000, tested to meet or exceed 1,000,000 cycles.
- B. Product: Subject to compliance with requirements, provide scheduled products manufactured by Yale; an ASSA Abloy Company, (YAL). Owner Standard – No substitutions.
- C. Requirements:
 1. Latchbolt: Steel with minimum ½" throw deadlatch on keyed and exterior functions; ¾" throw anti-friction latchbolt on pairs of doors.
 2. Strikes: Provide manufacturer's standard strike, ANSI curved lip, 1 ¼" x 4 7/8", 16 gauge, with 1" deep box construction, for each lock bolt or latchbolt.

2.4 LOCK CYLINDERS

- A. Lock Cylinders: Medeco high security K3S cylinders. Contractor to provide factory keyed cylinders, per owner's keying direction provided at keying meeting. A letter of authorization will be provided by the university to the contractor upon award of any contract allowing the purchase of restricted section product. Owner Standard – No Substitutions.
- B. Keys: Contractor to provide two cut keys per cylinder. One box of key blanks are also to be provided for every thirty (30) cylinders on the project. When less than 30 cylinders are required on a project, no key blanks need to be provided.
- C. Cylinders, keys, and key blanks shall be furnished by the contractor and shipped directly from the manufacturer to the campus lockshop in facilities maintenance at MSU. Shipping labels should be clearly labeled with the university's project number and sent to the following address:
 - a. Missouri State University, Facilities Management, ATTN: Academic Locksmith. 901 South National Avenue, Springfield, MO 65897

2.5 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Match owner's existing keying, and incorporate decisions made in keying conference.

2.6 EXIT DEVICES AND AUXILIARY ITEMS

- A. Exit Devices and Auxiliary Items: BHMA A156.3. Grade 1; except with extended cycle performance testing certified for minimum 8,000,000 cycles; listed by UL for accident and hazard; and conforming to applicable requirements of NFPA 80 and NFPA 101.
 1. Product: Subject to compliance with requirements, provide scheduled products manufactured by Von Duprin; Allegion, PLC. (VON). Owner Standard – No Substitutions.
 2. Requirements:
 - a. Internal springs: Coil compression type
 - b. Provide security dead latching for active latch bolts
 - c. Latch Bolts: Self lubricating coating to reduce friction and wear. Plated latchbolts are not acceptable.

- d. Touch Pad: Stainless steel with return stroke fluid dampers and rubber bottoming dampers.
- e. Provide filler plates and shim kits as needed for flush mounting of devices on doors.
- f. Devices with exposed rivets or screws on back of device that would be visible through a glass light are not acceptable.

2.7 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4 Grade 1; except tested to exceed 10 million (10,000,000) full load operating cycles by an independent test laboratory;
 - 1. Product: Subject to compliance with requirements, provide products manufactured by LCN Closers; Allegion, PLC,. (LCN) Owner Standard – No Substitutions.
 - a. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use.
 - b. Provide factory-sized rack-and-pinion hydraulic type closers that are adjustable to meet field conditions and requirements for opening force.
 - c. Provide closers, constructed with high strength cast iron cylinders, forged main arms, and one piece forged steel pistons, with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm.
 - d. Cylinder Body: 1½" piston diameter with 3/4" journal double heat treated shaft, 5/8" full complement bearing, chrome silicon steel spring.
 - e. Hydraulic Fluid: ULTRA X TM fluid with constant temperature control from +120o F (49o C) to -30o F (-35o C).
 - f. Closers with pressure release valves are not acceptable.
 - g. Closers shall be installed with thru-bolts.

2.8 MECHANICAL STOPS AND HOLDERS

- A. Wall- and Floor-Mounted Stops: BHMA A156.16.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide scheduled product manufactured by IVES Hardware; Allegion, PLC, (IVE) or a comparable product by:
 - a. Hager Companies. (HAG)
 - b. Rockwood Manufacturing Company. (ROC)
- B. Provide door stops for all doors in accordance with the following requirements:
 - 1. Provide convex type wall stops wherever possible.
 - 2. Where wall stops cannot be used, provide floor stops of the proper height.
 - 3. At opening where wall or floor stop cannot be used, provide overhead stop.
 - a. OVERHEAD STOPS AND HOLDERS
- C. Overhead Stops and Holders: BHMA A156.8.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide scheduled product manufactured by Glynn-Johnson; Allegion, PLC, (GLY) or comparable product by one of the following:
 - a. Architectural Builders Hardware Mfg., Inc. (ABH)
 - b. Rockwood Manufacturing Company. (ROC)

2.9 DOOR GASKETING

- A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
 - 1. Manufacturers: Subject to compliance with requirements, provide the scheduled product or comparable product by one of the following:
 - a. [Hager Companies](#). (HAG)
 - b. [National Guard Products](#). (NGP)
 - c. [Reese Enterprises, Inc.](#) (REE)
 - d. [Zero International](#). (ZER)

2.10 THRESHOLDS

- A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide the scheduled product or comparable product by one of the following:
 - a. [Hager Companies](#).
 - b. [National Guard Products](#).
 - c. [Reese Enterprises, Inc.](#)
 - d. [Zero International](#).

2.11 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
 - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 - 2. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
 - 3. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.12 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 EXECUTION

3.1 HARDWARE INSTALLATION

- A. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

- B. Mounting Heights: Mount door hardware units at heights indicated or as required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 - 2. Custom Steel Doors and Frames: HMMA 831.
- C. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- D. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- E. Temporary Construction Cylinders: Install construction cylinders to secure building and areas during construction period.
- F. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room. Verify location with Architect.
 - 1. Configuration: Provide least number of power supplies required to adequately serve doors with electrified door hardware.
- G. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."
- H. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
- I. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- J. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- K. Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.2 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. Tests and Inspections: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

3.3 DOOR HARDWARE SCHEDULE

END OF SECTION 08 71 00

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ART ANNEX HARDWARE SCHEDULE

HARDWARE SET: 01

FOR USE ON DOOR #(S):

100BA

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY EPT	628	IVE
2	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-LC-QEL-9947-EO-CON 24 VDC	626AM	VON
1	EA	ELEC PANIC HARDWARE	RX-LC-QEL-9947-NL-OP-110MD- CON 24 VDC	626AM	VON
1	EA	LFIC RIM CYLINDER	MEDECO K3S KEYWAY	626	MED
2	EA	LONG DOOR PULL	9264F 36"	630	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH	689	LCN
1	EA	SURF. AUTO OPERATOR	9542	ANCLR	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA SRT	689	LCN
1	EA	CUSH SHOE SUPPORT	4040XP-30 SRT	689	LCN
1	EA	BLADE STOP SPACER	4040XP-61 SRT	689	LCN
2	EA	ACTUATOR, WALL MOUNT	8310-853T	630	LCN
2	EA	DOOR SWEEP	345ANB	AL	PEM

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	THRESHOLD	171A	AL	PEM
4	EA	WIRE HARNESS	CON X LENGTH REQ'D		SCH
2	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
1	EA	POWER SUPPLY	PS902 900-4RL 120/240 VAC	LGR	SCE
1	EA	WEATHERSTRIP/GASKET	BY DOOR/FRAME MANUF		
		ING			
1	EA	CARD READER	BY SECURITY SYSTEM		
			INTEGRATOR		
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM		
			INTEGRATOR		

OPERATION: DOORS LOCKED/UNLOCKED ON TIME SCHEDULE VIA ACCESS CONTROL SYSTEM. WHEN LOCKED, ENTRY BY CARD READER, MOMENTARILY RETRACTING DEVICE LATCH AT LARGER LEAF. INSIDE PUSH PADS ALWAYS FREE EGRESS.

ADA ENTRY BY EXTERIOR ACTUATOR WHEN DOORS ARE DOGGED, OR AFTER VALID CARD READ. ADA EGRESS BY INTERIOR ACTUATOR AT ALL TIMES. PRESSING INTERIOR ACTUATOR FIRST RETRACTS DEVICE LATCH, THEN INITIATES AUTO OPERATOR CYCLE.

HARDWARE SET: 02

FOR USE ON DOOR #(S):

100AA

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY EPT	628	IVE
2	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-LC-QEL-9947-EO-CON 24 VDC	626AM	VON
1	EA	ELEC PANIC HARDWARE	RX-LC-QEL-9947-NL-OP-110MD-CON 24 VDC	626AM	VON
1	EA	LFIC RIM CYLINDER	MEDECO K3S KEYWAY	626	MED
2	EA	LONG DOOR PULL	9264F 36"	630	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH	689	LCN
1	EA	SURF. AUTO OPERATOR	9542	ANCLR	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA SRT	689	LCN
1	EA	CUSH SHOE SUPPORT	4040XP-30 SRT	689	LCN
1	EA	BLADE STOP SPACER	4040XP-61 SRT	689	LCN
1	EA	ACTUATOR, WALL MOUNT	8310-853T	630	LCN
1	EA	ACTUATOR, BOLLARD MOUNT	S-4X4-3-US32D	630	WIK
1	EA	BOLLARD	SQ25 W/ CR AND ADA PREP	630	WIK
2	EA	DOOR SWEEP	345ANB	AL	PEM
1	EA	THRESHOLD	171A	AL	PEM
4	EA	WIRE HARNESS	CON X LENGTH REQ'D		SCH

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
1	EA	POWER SUPPLY	PS902 900-4RL 120/240 VAC	LGR	SCE
1	EA	WEATHERSTRIP/GASKET	BY DOOR/FRAME MANUF		
		ING			
1	EA	CARD READER	BY SECURITY SYSTEM		
			INTEGRATOR		
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM		
			INTEGRATOR		

OPERATION: DOORS LOCKED/UNLOCKED ON TIME SCHEDULE VIA ACCESS CONTROL SYSTEM. WHEN LOCKED, ENTRY BY CARD READER, MOMENTARILY RETRACTING DEVICE LATCH AT LARGER LEAF. INSIDE PUSH PADS ALWAYS FREE EGRESS.

ADA ENTRY BY EXTERIOR ACTUATOR WHEN DOORS ARE DOGGED, OR AFTER VALID CARD READ. ADA EGRESS BY INTERIOR ACTUATOR AT ALL TIMES. PRESSING INTERIOR ACTUATOR FIRST RETRACTS DEVICE LATCH, THEN INITIATES AUTO OPERATOR CYCLE.

HARDWARE SET: 03

FOR USE ON DOOR #(S):

104A

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	REMOVABLE MULLION	KR4954	689	VON
1	EA	ELEC PANIC HARDWARE	LD-RX-LC-99-EO	626AM	VON
1	EA	ELEC PANIC HARDWARE	RX-LC-QEL-99-L-03-CON 24 VDC	626AM	VON
1	EA	LFIC RIM CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
2	EA	SURFACE CLOSER	4040XP RW/PA	689	LCN
2	EA	FLOOR STOP	FS444	626	IVE
1	EA	RAIN DRIP	346C	AL	PEM
2	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE
1	EA	CARD READER	BY SECURITY SYSTEM INTEGRATOR		
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: DOORS NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER, MOMENTARILY RETRACTING DEVICE LATCH AT ACTIVE LEAF. INSIDE PUSH PADS ALWAYS FREE EGRESS.

NOTE: BALANCE OF HARDWARE PROVIDED BY STC DOOR ASSEMBLY
MANUFACTURER

HARDWARE SET: 04

FOR USE ON DOOR #(S):

161AA 170A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HW HINGE	BB1199 NRP	630	HAG
1	EA	STOREROOM LOCKSET	CRSL 8805FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP SCUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	346C	AL	PEM
1	SET	SEALS	2891APK	AL	PEM
1	EA	DOOR SWEEP	345ANB	AL	PEM
1	EA	THRESHOLD	2005A	AL	PEM
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: DOOR CONTACT MONITORS DOOR POSITION

HARDWARE SET: 05

FOR USE ON DOOR #(S):

100AB 100BB

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY	628	IVE
2	EA	DUMMY PUSH BAR	330	626AM	VON
2	EA	LONG DOOR PULL	9264F 36"	630	IVE
1	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
1	EA	SURF. AUTO OPERATOR	9542	ANCLR	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA SRT	689	LCN
1	EA	CUSH SHOE SUPPORT	4040XP-30 SRT	689	LCN
1	EA	BLADE STOP SPACER	4040XP-61 SRT	689	LCN
2	EA	ACTUATOR, WALL MOUNT	8310-853T	630	LCN
2	EA	DOOR SWEEP	18100CNB	AL	PEM
1	EA	WEATHERSTRIP/GASKET	BY DOOR/FRAME MANUF		
		ING			

HARDWARE SET: 06

FOR USE ON DOOR #(S):

207TA

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	PANIC HARDWARE	99-L-03	626AM	VON
1	EA	LFIC RIM CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP RW/PA	689	LCN
1	EA	WALL STOP	WS406/407CCV	630	IVE

NOTE: BALANCE OF HARDWARE BY STC DOOR ASSEMBLY MANUFACTURER

HARDWARE SET: 07

FOR USE ON DOOR #(S):

104DC

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC FIRE EXIT HARDWARE	RX-LC-99-L-F-M996-03-FS-CON	626AM	VON
1	EA	LFIC RIM CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP RW/PA	689	LCN
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	WIRE HARNESS	CON X LENGTH REQ'D		SCH
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
1	EA	POWER SUPPLY	BY SECURITY SYSTEM INTEGRATOR		
1	EA	CARD READER	BY SECURITY SYSTEM INTEGRATOR		
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: DOOR NORMALLY CLOSED AND LOCKED ON STAIR SIDE. ENTRY TO FLOOR BY CARD READER, MOMENTARILY UNLOCKING LEVER TRIM. INSIDE PUSH PAD ALWAYS FREE EGRESS INTO STAIR.

NOTE: BALANCE OF HARDWARE BY STC DOOR ASSEMBLY MANUFACTURER

HARDWARE SET: 08

FOR USE ON DOOR #(S):

161B 261A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	BB1168	652	HAG
1	EA	FIRE EXIT HARDWARE	99-L-BE-F-03	626AM	VON
1	EA	SURFACE CLOSER	4040XP 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	GASKET	S88BL	BLK	PEM

HARDWARE SET: 09

FOR USE ON DOOR #(S):

161AB

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	BB1168	652	HAG
1	EA	FIRE EXIT HARDWARE	99-L-BE-F-03	626AM	VON
1	EA	SURFACE CLOSER	4040XP 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	GASKET	S88BL	BLK	PEM
1	EA	AUTO DOOR BOTTOM	412CSL	AL	PEM

HARDWARE SET: 10

FOR USE ON DOOR #(S):

104AB

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	FIRE EXIT HARDWARE	99-L-BE-F-03	626AM	VON
1	EA	SURFACE CLOSER	4040XP RW/PA	689	LCN
1	EA	WALL STOP	WS406/407CCV	630	IVE

NOTE: BALANCE OF HARDWARE BY STC DOOR ASSEMBLY MANUFACTURER

HARDWARE SET: 11

FOR USE ON DOOR #(S):

104AA

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-LC-QEL-99-L-03-CON 24 VDC	626AM	VON
1	EA	LFIC RIM CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP RW/PA	689	LCN
1	EA	FLOOR STOP	FS439	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
2	EA	WIRE HARNESS	CON X LENGTH REQ'D		SCH
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE
1	EA	CARD READER	BY SECURITY SYSTEM INTEGRATOR		
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER, MOMENTARILY RETRACTING DEVICE LATCH. INSIDE PUSH PAD ALWAYS FREE EGRESS.

NOTE: BALANCE OF HARDWARE BY STC DOOR ASSEMBLY MANUFACTURER

HARDWARE SET: 12

FOR USE ON DOOR #(S):

201B	202A	203A	204B	205A	206A
207A	208A	209A			

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	POWER TRANSFER	CEPT-10	689	SEC
1	EA	EU MORTISE LOCK	CRSL 8891FL REX LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP RW/PA	689	LCN
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
2	EA	WIRE HARNESS	ELECTROLYNX HARNESS X SIZE REQ'D		ASA
1	EA	POWER SUPPLY	BY SECURITY SYSTEM INTEGRATOR		
1	EA	CARD READER	BY SECURITY SYSTEM INTEGRATOR		
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER,
MOMENTARILY UNLOCKING OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE EGRESS.

NOTE: PROVIDE FLOOR STOP IN LIEU OF WALL STOP WHERE REQUIRED

HARDWARE SET: 13

FOR USE ON DOOR #(S):

101A 190A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	BB1279	652	HAG
1	EA	ELEC. HINGE	BB1279 ETW QC	652	HAG
1	EA	EU MORTISE LOCK	CRSL 8891FL REX LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP 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	GASKET	S88BL	BLK	PEM
1	EA	AUTO DOOR BOTTOM	412CSL	AL	PEM
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
2	EA	WIRE HARNESS	ELECTROLYNX HARNESS X SIZE REQ'D		ASA
1	EA	POWER SUPPLY	BY SECURITY SYSTEM INTEGRATOR		
1	EA	CARD READER	BY SECURITY SYSTEM INTEGRATOR		
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER,
MOMENTARILY UNLOCKING OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE EGRESS.

HARDWARE SET: 14

FOR USE ON DOOR #(S):

104DA 104DB

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	BB1279	652	HAG
1	EA	ELEC. HINGE	BB1279 ETW QC	652	HAG
1	EA	EU MORTISE LOCK	CRSL 8891FL REX LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKET	S88BL	BLK	PEM
1	EA	AUTO DOOR BOTTOM	412CSL	AL	PEM
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
2	EA	WIRE HARNESS	ELECTROLYNX HARNESS X SIZE REQ'D		ASA
1	EA	POWER SUPPLY	BY SECURITY SYSTEM INTEGRATOR		
1	EA	CARD READER	BY SECURITY SYSTEM INTEGRATOR		
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER,
MOMENTARILY UNLOCKING OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE EGRESS.

HARDWARE SET: 15

FOR USE ON DOOR #(S):

104BA 104FA 270AA

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	STOREROOM LOCKSET	CRSL 8805FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP RW/PA	689	LCN
1	EA	WALL STOP	WS406/407CCV	630	IVE

NOTE: BALANCE OF HARDWARE BY STC DOOR ASSEMBLY MANUFACTURER

NOTE: PROVIDE FLOOR STOP IN LIEU OF WALL STOP WHERE REQUIRED

HARDWARE SET: 16

FOR USE ON DOOR #(S):

204AA

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	BB1279	652	HAG
1	EA	STOREROOM LOCKSET	CRSL 8805FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKET	S88BL	BLK	PEM
1	EA	AUTO DOOR BOTTOM	412CSL	AL	PEM

HARDWARE SET: 17

FOR USE ON DOOR #(S):

270A

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	SURFACE BOLT	SB360 12"	604	IVE
1	EA	STOREROOM LOCKSET	CRSL 8805FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
2	EA	FLOOR STOP	FS439	630	IVE

NOTE: BALANCE OF HARDWARE BY STC DOOR ASSEMBLY MANUFACTURER

HARDWARE SET: 18

FOR USE ON DOOR #(S):

203AA

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	BB1279	652	HAG
1	EA	STOREROOM LOCKSET	CRSL 8805FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	OH STOP	90S	630	GLY
1	EA	GASKET	S88BL	BLK	PEM
1	EA	AUTO DOOR BOTTOM	412CSL	AL	PEM

HARDWARE SET: 19

FOR USE ON DOOR #(S):

280A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	BB1279	652	HAG
1	EA	STOREROOM LOCKSET	CRSL 8805FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP 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: 20

FOR USE ON DOOR #(S):

181A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	BB1279	652	HAG
1	EA	STOREROOM LOCKSET	CRSL 8805FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP 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	GASKET	S88BL	BLK	PEM
1	EA	AUTO DOOR BOTTOM	412CSL	AL	PEM

HARDWARE SET: 21

FOR USE ON DOOR #(S):

180A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	BB1279	652	HAG
1	EA	STOREROOM LOCKSET	CRSL 8805FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	OH STOP	90S	630	GLY
1	EA	SURFACE CLOSER	4040XP RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKET	S88BL	BLK	PEM
1	EA	AUTO DOOR BOTTOM	412CSL	AL	PEM

HARDWARE SET: 22

FOR USE ON DOOR #(S):

190B 201A 203B 204A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CLASSROOM LOCKSET	CRSL 8808FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP RW/PA	689	LCN
1	EA	WALL STOP	WS406/407CCV	630	IVE

NOTE: BALANCE OF HARDWARE BY STC DOOR ASSEMBLY MANUFACTURER

HARDWARE SET: 23

FOR USE ON DOOR #(S):

102A 103A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	BB1279	652	HAG
1	EA	OFFICE LOCKSET	CRSL 8809FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	OH STOP	90S	630	GLY
1	EA	SURFACE CLOSER	4040XP RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKET	S88BL	BLK	PEM

HARDWARE SET: 24

FOR USE ON DOOR #(S):

153RA 250RA 251RA

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	BB1279	652	HAG
1	EA	DORMITORY LOCKSET W/ INDICATOR	CRSL 8822FL IND	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP 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	GASKET	S88BL	BLK	PEM
1	EA	AUTO DOOR BOTTOM	412CSL	AL	PEM

HARDWARE SET: 25

FOR USE ON DOOR #(S):

150RA 151RA

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	BB1279	652	HAG
1	EA	MAXUM DEADBOLT, CLASSROOM FUNCTION	11C61X K3S KEYWAY	626	MED
1	EA	PUSH PLATE	8200 4" X 16"	630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16"	630	IVE
1	EA	SURFACE CLOSER	4040XP 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	GASKET	S88BL	BLK	PEM
1	EA	AUTO DOOR BOTTOM	412CSL	AL	PEM

NOTE: PROVIDE FLOOR STOP IN LIEU OF WALL STOP AT DOOR 151RA

HARDWARE SET: 26

FOR USE ON DOOR #(S):

104BB 104BC

PROVIDE EACH PDP DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	POCKET DOOR KIT	1500SC/1560SC AS REQ'D	AL	JOH
1	EA	POCKET DOOR ENTRY LOCK	CS2002CPDL-3	626	ACC
1	EA	POCKET DOOR PULL/STRIKE	2002CPDS	626	ACC
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED

CRAIG HALL HARDWARE SCHEDULE

HARDWARE SET: 01

FOR USE ON DOOR #(S):

100AC 100BA

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY EPT	628	IVE
2	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	LD-RX-LC-9947-EO-CON	626AM	VON
1	EA	ELEC PANIC HARDWARE	RX-LC-QEL-9947-NL-OP-110MD- CON 24 VDC	626AM	VON
1	EA	LFIC RIM CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	LONG DOOR PULL	9264F 36" (AT LARGER LEAF)	630	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH	689	LCN
1	EA	SURF. AUTO OPERATOR	9542 (AT LARGER LEAF)	ANCLR	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA SRT	689	LCN
1	EA	CUSH SHOE SUPPORT	4040XP-30 SRT	689	LCN
1	EA	BLADE STOP SPACER	4040XP-61 SRT	689	LCN
1	EA	ACTUATOR, JAMB MOUNT	8310-818T	630	LCN
1	EA	ACTUATOR, BOLLARD MOUNT	S-4X4-3-US32D	630	WIK
1	EA	BOLLARD	SQ25 W/ CR AND ADA PREP	630	WIK
2	EA	DOOR SWEEP	345ANB	AL	PEM
1	EA	THRESHOLD	171A	AL	PEM

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	WIRE HARNESS	CON X LENGTH REQ'D		SCH
2	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
1	EA	POWER SUPPLY	PS902 900-4RL 120/240 VAC	LGR	SCE
1	EA	WEATHERSTRIP/GASKET	BY DOOR/FRAME MANUF		
		ING			
1	EA	CARD READER	BY SECURITY SYSTEM		
			INTEGRATOR		
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM		
			INTEGRATOR		

OPERATION: DOORS LOCKED/UNLOCKED ON TIME SCHEDULE VIA ACCESS CONTROL SYSTEM. WHEN LOCKED, ENTRY BY CARD READER, MOMENTARILY RETRACTING DEVICE LATCH AT LARGER LEAF. INSIDE PUSH PADS ALWAYS FREE EGRESS.

ADA ENTRY BY EXTERIOR ACTUATOR WHEN DOORS ARE DOGGED, OR AFTER VALID CARD READ. ADA EGRESS BY INTERIOR ACTUATOR AT ALL TIMES. PRESSING INTERIOR ACTUATOR FIRST RETRACTS DEVICE LATCH, THEN INITIATES AUTO OPERATOR CYCLE.

HARDWARE SET: 02

FOR USE ON DOOR #(S):

100AA 100AB 100BB 100BC

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY EPT	628	IVE
2	EA	POWER TRANSFER	EPT10 CON	689	VON
2	EA	ELEC PANIC HARDWARE	RX-LC-QEL-9947-EO-CON 24 VDC	626AM	VON
2	EA	LONG DOOR PULL	9264F 36"	630	IVE
2	EA	SURFACE CLOSER	4040XP SCUSH	689	LCN
2	EA	PA MOUNTING PLATE	4040XP-18PA SRT	689	LCN
2	EA	CUSH SHOE SUPPORT	4040XP-30 SRT	689	LCN
2	EA	BLADE STOP SPACER	4040XP-61 SRT	689	LCN
2	EA	DOOR SWEEP	345ANB	AL	PEM
1	EA	THRESHOLD	171A	AL	PEM
4	EA	WIRE HARNESS	CON X LENGTH REQ'D		SCH
2	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE
1	EA	WEATHERSTRIP/GASKET	BY DOOR/FRAME MANUF ING		
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: DOORS LOCKED/UNLOCKED ON TIME SCHEDULE VIA ACCESS CONTROL SYSTEM. INSIDE PUSH PADS ALWAYS FREE EGRESS.

HARDWARE SET: 03

FOR USE ON DOOR #(S):

101HB

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HW HINGE	BB1199 NRP	630	HAG
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-LC-QEL-99-L-06-CON 24 VDC	626AM	VON
1	EA	LFIC RIM CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP EDA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS444	626	IVE
1	EA	RAIN DRIP	346C	AL	PEM
1	SET	SEALS	2891APK	AL	PEM
1	EA	DOOR SWEEP	345ANB	AL	PEM
1	EA	THRESHOLD	2005A	AL	PEM
2	EA	WIRE HARNESS	CON X LENGTH REQ'D		SCH
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE
1	EA	CARD READER	BY SECURITY SYSTEM INTEGRATOR		
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER, MOMENTARILY RETRACTING DEVICE LATCH. INSIDE PUSH PAD ALWAYS FREE EGRESS.

HARDWARE SET: 04

FOR USE ON DOOR #(S):

140B 141B

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HW HINGE	BB1199 NRP	630	HAG
1	EA	FIRE RATED REMOVABLE MULLION	KR9954	689	VON
2	EA	FIRE EXIT HARDWARE	99-EO-F	626AM	VON
2	EA	SURFACE CLOSER	4040XP EDA	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
2	EA	FLOOR STOP	FS444	626	IVE
1	EA	RAIN DRIP	346C	AL	PEM
1	SET	SEALS	2891APK	AL	PEM
1	EA	ASTRAGAL SET	305CN	AL	PEM
2	EA	DOOR SWEEP	345ANB	AL	PEM
1	EA	THRESHOLD	2005A	AL	PEM
2	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC	WHT	SCE
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: DOOR CONTACTS MONITOR DOOR POSITION

HARDWARE SET: 05

FOR USE ON DOOR #(S):

101HA

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	PIVOT SET	7215 SET	626	IVE
4	EA	INTERMEDIATE PIVOT	7215 INT	626	IVE
1	EA	AUTO FLUSH BOLT	FB31T (AT TOP BOLT)	630	IVE
1	EA	MANUAL FLUSH BOLT	FB458	626	IVE
1	EA	DUST PROOF STRIKE	DP1/DP2 AS REQ'D	626	IVE
1	EA	STOREROOM LOCKSET	CRSL 8805FL LESS CYL	626	YAL
2	EA	OH STOP	100S	630	GLY
1	EA	RAIN DRIP	346C	AL	PEM
1	SET	SEALS	2891APK	AL	PEM
1	EA	ASTRAGAL SET	305CN	AL	PEM
1	EA	DOOR SWEEP	345ANB	AL	PEM
1	EA	THRESHOLD	2005A	AL	PEM
2	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: DOOR CONTACTS MONITOR DOOR POSITION

HARDWARE SET: 06

FOR USE ON DOOR #(S):

100AF 100BD

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY	628	IVE
2	EA	DUMMY PUSH BAR	330	626AM	VON
1	EA	LONG DOOR PULL	9264F 36" (AT LARGER LEAF)	630	IVE
1	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
1	EA	SURF. AUTO OPERATOR	9542 (AT LARGER LEAF)	ANCLR	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA SRT	689	LCN
1	EA	CUSH SHOE SUPPORT	4040XP-30 SRT	689	LCN
1	EA	BLADE STOP SPACER	4040XP-61 SRT	689	LCN
2	EA	ACTUATOR, JAMB MOUNT	8310-818T	630	LCN
1	EA	FLOOR STOP	FS439	630	IVE
2	EA	DOOR SWEEP	18100CNB	AL	PEM
1	EA	WEATHERSTRIP/GASKET	BY DOOR/FRAME MANUF ING		

HARDWARE SET: 07

FOR USE ON DOOR #(S):

100AD 100AE 100BE 100BF

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY	628	IVE
2	EA	DUMMY PUSH BAR	330	626AM	VON
2	EA	LONG DOOR PULL	9264F 36"	630	IVE
2	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
2	EA	PA MOUNTING PLATE	4040XP-18PA SRT	689	LCN
2	EA	CUSH SHOE SUPPORT	4040XP-30 SRT	689	LCN
2	EA	BLADE STOP SPACER	4040XP-61 SRT	689	LCN
2	EA	DOOR SWEEP	18100CNB	AL	PEM
1	EA	WEATHERSTRIP/GASKET	BY DOOR/FRAME MANUF		
		ING			

HARDWARE SET: 08

FOR USE ON DOOR #(S):

242A 243A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	BB1168	652	HAG
1	EA	FIRE EXIT HARDWARE	99-L-BE-F-03	626AM	VON
1	EA	SURFACE CLOSER	4040XP 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	GASKET	S88BL	BLK	PEM

HARDWARE SET: 09

FOR USE ON DOOR #(S):

101A	101B	101C	101D	101E	101F
101G	101H	208B	208D		

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	BB1279	652	HAG
1	EA	PANIC HARDWARE	QM-99-L-QM996-03	626AM	VON
1	EA	SURFACE CLOSER	4040XP 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	GASKET	S88BL	BLK	PEM
1	EA	AUTO DOOR BOTTOM	412CSL	AL	PEM

HARDWARE SET: 10

FOR USE ON DOOR #(S):

142A 143A

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	BB1168	652	HAG
1	EA	FIRE RATED REMOVABLE MULLION	KR9954	689	VON
1	EA	FIRE EXIT HARDWARE	99-EO-F	626AM	VON
1	EA	FIRE EXIT HARDWARE	99-L-F-03	626AM	VON
1	EA	LFIC RIM CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
2	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	MULLION SEAL	8780NBK PSA	BK	ZER
1	EA	GASKET	S88BL	BLK	PEM
1	EA	ASTRAGAL (SET)	18041CNB	AL	PEM

HARDWARE SET: 11

FOR USE ON DOOR #(S):

140A 141A

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	BB1168	652	HAG
1	EA	FIRE RATED REMOVABLE MULLION	KR9954	689	VON
1	EA	FIRE EXIT HARDWARE	99-EO-F	626AM	VON
1	EA	FIRE EXIT HARDWARE	99-L-BE-F-03	626AM	VON
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
2	EA	SURFACE CLOSER	4040XP RW/PA	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS439	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	MULLION SEAL	8780NBK PSA	BK	ZER
1	EA	GASKET	S88BL	BLK	PEM
1	EA	ASTRAGAL (SET)	18041CNB	AL	PEM

HARDWARE SET: 12

FOR USE ON DOOR #(S):

206A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	HINGE	BB1279	652	HAG
1	EA	ELEC. HINGE	BB1279 ETW QC	652	HAG
1	EA	EU MORTISE LOCK	CRSL 8891FL REX LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP 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	GASKET	S88BL	BLK	PEM
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
2	EA	WIRE HARNESS	ELECTROLYNX HARNESS X SIZE REQ'D		ASA
1	EA	POWER SUPPLY	BY SECURITY SYSTEM INTEGRATOR		
1	EA	CARD READER	BY SECURITY SYSTEM INTEGRATOR		
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER,
MOMENTARILY UNLOCKING OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE EGRESS.

HARDWARE SET: 13

FOR USE ON DOOR #(S):

102A	103A	107.1TA	144A	144B	203A
203B	246A				

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	BB1279	652	HAG
1	EA	STOREROOM LOCKSET	CRSL 8805FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP 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	GASKET	S88BL	BLK	PEM
3	EA	SILENCER	SR64 (AT NON-RATED DOORS)	GRY	IVE

HARDWARE SET: 14

FOR USE ON DOOR #(S):

101KA

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	BB1279	652	HAG
1	EA	STOREROOM LOCKSET	CRSL 8805FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP 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	GASKET	S88BL	BLK	PEM
1	EA	AUTO DOOR BOTTOM	412CSL	AL	PEM

HARDWARE SET: 15

FOR USE ON DOOR #(S):

299A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	BB1279	652	HAG
1	EA	STOREROOM LOCKSET	CRSL 8805FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKET	S88BL (AT FIRE RATED DOORS)	BLK	PEM
3	EA	SILENCER	SR64 (AT NON-RATED DOORS)	GRY	IVE

HARDWARE SET: 16

FOR USE ON DOOR #(S):

211A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	BB1279	652	HAG
1	EA	STOREROOM LOCKSET	CRSL 8805FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKET	S88BL (AT FIRE RATED DOORS)	BLK	PEM
3	EA	SILENCER	SR64 (AT NON-RATED DOORS)	GRY	IVE

HARDWARE SET: 17

FOR USE ON DOOR #(S):

106A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112XY	628	IVE
1	EA	CLASSROOM LOCKSET	CRSL 8808FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP RW/PA	689	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA SRT	689	LCN
1	EA	BLADE STOP SPACER	4040XP-61 SRT	689	LCN
1	EA	WALL STOP	WS406/407CCV	630	IVE

HARDWARE SET: 18

FOR USE ON DOOR #(S):

101HC

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CLASSROOM LOCKSET	CRSL 8808FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP RW/PA	689	LCN
1	EA	FLOOR STOP	FS439	630	IVE

NOTE: BALANCE OF HARDWARE BY STC DOOR ASSEMBLY MANUFACTURER

HARDWARE SET: 19

FOR USE ON DOOR #(S):

209A 216A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	BB1279	652	HAG
1	EA	OFFICE LOCKSET	CRSL 8809FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

NOTE: PROVIDE FLOOR STOP IN LIEU OF WALL STOP AT DOOR 209A

HARDWARE SET: 20

FOR USE ON DOOR #(S):

204A 205A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	BB1279	652	HAG
1	EA	OFFICE LOCKSET	CRSL 8809FL LESS CYL	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP 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	GASKET	S88BL	BLK	PEM

HARDWARE SET: 21

FOR USE ON DOOR #(S):

101LA 109A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	BB1279	652	HAG
1	EA	DORMITORY LOCKSET W/ INDICATOR	CRSL 8822FL IND	626	YAL
1	EA	CONV. MORTISE CYLINDER	MEDECO K3S KEYWAY	626	MED
1	EA	SURFACE CLOSER	4040XP 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: 22

FOR USE ON DOOR #(S):

104A 105A 244A 245A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	BB1279	652	HAG
1	EA	MAXUM DEADBOLT, CLASSROOM FUNCTION	11C61X K3S KEYWAY	626	MED
1	EA	PUSH PLATE	8200 4" X 16"	630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16"	630	IVE
1	EA	SURFACE CLOSER	4040XP 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: 23

FOR USE ON DOOR #(S):

208A 208C

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	BB1279	652	HAG
1	EA	MAXUM DEADBOLT, CLASSROOM FUNCTION	11C61X K3S KEYWAY	626	MED
1	EA	PUSH PLATE	8200 4" X 16"	630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16"	630	IVE
1	EA	SURFACE CLOSER	4040XP 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	GASKET	S88BL	BLK	PEM
1	EA	AUTO DOOR BOTTOM	412CSL	AL	PEM

HARDWARE SET: 24

FOR USE ON DOOR #(S):

101HD

PROVIDE EACH RU DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
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NOTE: ALL HARDWARE BY DOOR MANUFACTURER

END OF SECTION 08 71 00

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**SECTION 08 80 00
GLAZING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Insulating glass units.
- B. Glazing sealants.
- C. Miscellaneous glazing materials.

1.2 RELATED REQUIREMENTS

- A. Section 06 40 23 - Interior Architectural Woodwork.
- B. Section 07 92 00 - Joint Sealants: Sealants for other than glazing purposes.
- C. Section 08 11 13 - Hollow Metal Doors and Frames: Glazed lites in doors and borrowed lites.
- D. Section 08 43 13 - Aluminum-Framed Entrances: Glazing provided as part of storefront assembly.
- E. Section 08 44 13 - Glazed Aluminum Curtain Walls: Glazing provided as part of wall assembly.
- F. Section 08 44 35 - Fire-Rated Glazed Assemblies: Glazing fire-tested as part of wall assembly.

1.3 1.2 DEFINITIONS

- A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.
- D. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.
- E. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for 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.

1.4 REFERENCE STANDARDS

- A. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005 (Reapproved 2019).
- B. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- C. ASTM C1036 - Standard Specification for Flat Glass; 2021.
- D. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2018.
- E. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016 (Reapproved 2023).
- F. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass; 2021a.
- G. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.
- H. GANA (GM) - GANA Glazing Manual; 2022.
- I. GANA (SM) - GANA Sealant Manual; 2008.
- J. IGMA TM-3000 - North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use; 1990 (Reaffirmed 2016).

1.5 ADMINISTRATIVE REQUIREMENTS

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

1.6 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.7 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data on Insulating Glass Unit and Glazing Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- C. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- D. Samples: Submit one sample 12 by 12 inch in size for each glass type.
- E. Installer's qualification statement.
- F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- G. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.8 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA (GM) and IGMA TM-3000 for glazing installation methods. Maintain one copy on site.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience and approved by manufacturer.

1.9 MOCK-UPS

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

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing to avoid hermetic seal ruptures.

1.11 FIELD CONDITIONS

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

1.12 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form, made out to Owner and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: **Ten** years from date of Substantial Completion.
- C. Manufacturer's Special Warranty for 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: **Five** years from date of Substantial Completion.
- D. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 1. Warranty Period: **Ten** years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. 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 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. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:
- C.
 1. Design Wind Pressures: As indicated on Drawings .
 - a. Wind Design Data: As indicated on Drawings.
 2. Design Snow Loads: As indicated on Drawings.
 3. Probability of Breakage for Sloped Glazing: For glass sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.
 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, whichever is less.
 5. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.
- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
 1. For monolithic-glass lites, properties are based on units with lites 6 mm thick .
 2. For laminated-glass lites, properties are based on products of construction indicated.
 3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 4. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F.
 5. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
 6. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

2.2 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. NGA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
 - 2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
 - 3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
 - 4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing 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.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than thickness indicated.
- E. Minimum Glass Thickness for Exterior Lites: 6 mm .
 - 1. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
- F. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.3 GLASS MATERIALS

- A. Float Glass: Provide float glass based glazing unless otherwise indicated.
 - 1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality - Q3.
- B. Kind HS - Heat-Strengthened Type: Complies with ASTM C1048. Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- C. Kind FT - Fully Tempered Type: Complies with ASTM C1048. Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- D. Ceramic-Coated Vision Glass: ASTM C1048, Condition C, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3; and complying with Specification No. 95-1-31 in NGA's "Engineering Standards Manual."

2.4 INSULATING GLASS UNITS

- A. Insulating Glass Units: Types as indicated.

- B. Basis-of-Design Manufacturers: Provide Viracon, or comparable product of other manufacturers approved by the Architect.
1. General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article and in Part 2 "Insulating-Glass Units" Article.
 - a. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
 - b. Provide Kind FT (fully tempered) glass lites where safety glass is indicated.
 - c. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
 2. Durability: Certified by an independent testing agency to comply with ASTM E2190.
 3. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
 4. Warm-Edge Spacers: Low-conductivity thermoplastic with desiccant warm-edge technology design.
 - a. Spacer Width: As required for specified insulating glass unit.
 - b. Spacer Height: Manufacturer's standard.
 5. Spacer Color: Black.
 6. Edge Seal:
 - a. Dual-Sealed System: Provide polyisobutylene sealant as primary seal applied between spacer and glass panes, and silicone, polysulfide, or polyurethane sealant as secondary seal applied around perimeter.
 - b. Color: Black.
 7. Purge interpane space with dry air, hermetically sealed.

2.5 GLAZING COMPOUNDS

- A. Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; nonbleeding, nonstaining; ASTM C920 Type S, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; color as selected by Architect from manufacturer's full range.
1. Compatibility: Select 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.
- B. Elastomeric Glazing Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

2.6 ACCESSORIES

- 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. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal:
 - 1. Neoprene.
 - 2. EPDM.
 - 3. Silicone.
 - 4. Thermoplastic polyolefin rubber.
 - 5. Any material indicated above.
- 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.
- D. Setting Blocks: Elastomeric, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4 inch by width of glazing rabbet space minus 1/16 inch by height to suit glazing method and pane weight and area.
- E. Spacer Shims: Elastomeric, 50 to 60 Shore A durometer hardness; ASTM C864 Option II. Continuous by one half the height of the glazing stop by thickness to suit application, self adhesive on one face.
- F. Glazing Tape, Back Bedding Mastic Type: Preformed, butyl-based, 100 percent solids compound with integral resilient spacer rod applicable to application indicated; 5 to 30 cured Shore A durometer hardness; coiled on release paper; black color.
 - 1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 - 2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- G. Glazing Tape: Closed cell polyvinyl chloride (PVC) foam, coiled on release paper over adhesive on two sides, maximum water absorption by volume of 2 percent, designed for compression of 25 percent to effect an air barrier and vapor retarder seal.
 - 1. Type 1, for glazing applications in which tape acts as the primary sealant.
 - 2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.
- H. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.
- I. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- J. 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.

2.7 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.
 - 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - a. Temperature Change: 120 deg F , ambient; 180 deg F , material surfaces .
- 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.

PART 3 EXECUTION

3.1 VERIFICATION OF CONDITIONS

- A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
- B. Verify that the minimum required face and edge clearances are being provided.
- C. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.
- D. Verify that sealing between joints of glass framing members has been completed effectively.
- E. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

3.3 INSTALLATION, GENERAL

- A. Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.
- B. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.
- C. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
- D. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches as follows:
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- H. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- I. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.
- J. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.

- K. Set glass lites of system with uniform pattern, draw, bow, and similar characteristics.
- L. Prevent glass from contact with any contaminating substances that may be the result of construction operations such as, and not limited to the following; weld splatter, fire-safing, plastering, mortar droppings, and paint.

3.4 INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

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

3.5 INSTALLATION - DRY GLAZING METHOD (TAPE AND TAPE)

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

3.6 INSTALLATION - WET GLAZING METHOD (SEALANT AND SEALANT)

- A. Application - Exterior Glazed: Set glazing infills from the exterior of the building.
- B. Place setting blocks at 1/4 points and install glazing pane or unit.
- C. Install removable stops with glazing centered in space by inserting spacer shims both sides at 24 inch intervals, 1/4 inch below sight line.
- D. Fill gaps between glazing and stops with sealant to depth of bite on glazing, but not more than 3/8 inch below sight line to ensure full contact with glazing and continue the air and vapor seal.
- E. Apply sealant to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

3.7 INSTALLATION - STRUCTURAL SILICONE GLAZING

- A. Application - Factory (Shop) Glazed: Follow basic guidelines of structural silicone glazing for glazing application.
 - 1. Two-Sided Structural: Glass structurally adhered to vertical mullions with horizontal sides captured in glazing pockets.
 - 2. Four-Sided Structural: Glass with four sides structurally adhered to horizontal and vertical metal back-up mullion.
- B. Provide design review of the glazing system and project details, adhesion testing, proper surface preparation, training and a quality service program.
- C. Provide only structural silicone sealant, tested and manufactured for structural glazing.

3.8 CLEANING

- A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
- B. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

- C. Remove nonpermanent labels immediately after glazing installation is complete.
- D. Clean glass and adjacent surfaces after sealants are fully cured.
- E. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.9 PROTECTION

- A. Protect exterior 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, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.

3.10 MONOLITHIC GLASS SCHEDULE

- A. Glass Type G1: Clear Annealed Fully tempered float glass.
 - 1. Minimum Thickness: 6 mm (1/4 inch).
 - 2. Safety glazing required.
 - 3. Location: As indicated on Drawings.
- B. Glass Type G2: Not being used
- C. Glass Type G3: Clear Acoustical Rated Glass. See Section 08 34 73 Sound Control Door and Window Assemblies for factory sound-rated glazing units. Sound-rated glazing to meet min. STC per drawings.
 - 1. Minimum Thickness: per STC rating required.
 - 2. Safety glazing required.
 - 3. Location: As indicated on Drawings.
- D. Glass Type G5: Clear Fire-Rated Glass. See Section 08 44 35 Fire-Rated Glazed Assemblies for factory-installed 120 min fire-rated glazing units.
 - 1. Minimum Thickness: per fire rating required.
 - 2. Safety glazing required.
 - 3. Location: As indicated on Drawings.

3.11 LAMINATED-GLASS SCHEDULE

- A. Glass Type G4: Clear Tempered Laminated Glass. See Section 05 73 11 Decorative Metal Stair and Glazed Metal Railings.

3.12 INSULATED GLASS SCHEDULE

- A. Glass Type IG1: 1" Clear Low-E Insulated Glass Unit
 - 1. Location: South, East, and West elevations.
 - 2. Basis-of-Design Product: Equal to Viracon VNE1-53
 - 3. Overall Unit Thickness: 1 inch.
 - 4. Minimum Thickness of Each Glass Lite: 6 mm.
 - 5. Interspace Content: Argon.
 - 6. Low-E Coating: Sputter coated on #2 surface.
 - 7. Winter Nighttime U-Factor: 0.24 maximum.
 - 8. Visible Light Transmittance: 49 percent minimum.
 - 9. Solar Heat Gain Coefficient (SHGC): 0.22 maximum.
 - 10. Shading Coefficient: 0.26

11. Light to Solar Gain Ration (LSG): 2.2
12. Spacer: Thermally-broken "warm edge" spacers.
13. Provide safety glazing labeling where drawings indicate fully tempered ("FT" or "T") glazing.
- B. Glass Type IG2: 1" Clear Low-E Insulated Glass Unit with Film for projection.
 1. Location: South elevation at room 201.
 2. Basis-of-Design Product: Equal to Viracon VNE1-53
 3. Overall Unit Thickness: 1 inch.
 4. Minimum Thickness of Each Glass Lite: 6 mm.
 5. Interspace Content: Argon.
 6. Low-E Coating: Sputter coated on #2 surface.
 7. Winter Nighttime U-Factor: 0.24 maximum.
 8. Visible Light Transmittance: 49 percent minimum.
 9. Solar Heat Gain Coefficient (SHGC): 0.22 maximum.
 10. Shading Coefficient: 0.26
 11. Light to Solar Gain Ration (LSG): 2.23
 12. Spacer: Thermally-broken "warm edge" spacers.
 13. Provide safety glazing labeling where drawings indicate fully tempered ("FT" or "T") glazing.
 14. Film for projection: Basis-of-Design Product Equal to SFB Clear UTD (ultra-thin display) Film manufactured by Smart-Film-Blinds, www.smartfilmblinds.com.
 - a. PSF Width 1000 - 2000mm
 - b. Transmittance: greater than 90%
 - c. Haze: Less than 2.0%
 - d. Viewing Angle: 170 degrees.
 - e. Resolutions: up to 8K.
 - f. Thickness: 0.3mm
 - g. Operating temperature: -20 to 60 degrees C.
- C. Glass Type IG3: 1" Insulating Coated SpandrwI Glass Units.
 1. Location: Per the drawings.
 2. Basis-of-Design Product: Equal to Viracon VNE1-53.
 3. Overall Unit Thickness: 1 inch.
 4. Exterior Glass Ply: 1/4" Clear, Heat Treatment-HS unless drawings indicate fully tempered ("FT" or "T") glazing.
 5. Low-E Coating: VNE-53 on #2 Surface.
 6. Spacer: 1/2" VTS black spacer - argon filled.
 7. Silicone: Black.
 8. Interior Glass Ply: 1/4" Clear, Heat Treatment-HS unless drawings indicate fully tempered ("FT" or "T") glazing.
 9. Ceramic Frit:
 - a. Surface #4.
 - b. Color: Warm Gray - V952.
 10. Winter Nighttime U-Factor: 0.24 maximum.
 11. Summer U-Value: 0.20.

12. Provide safety glazing labeling where drawings indicate fully tempered ("FT" or "T") glazing.
- D. Glass Type IG4: Clear Fire-Rated Insulated Unit.
 1. See Section 08 44 35 Fire-Rated Glazed Assemblies for factory-installed 120 min fire-rated glazing units.

END OF SECTION 08 80 00

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**SECTION 08 83 00
MIRRORS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Glass mirrors.
 - 1. Annealed float glass.

1.2 REFERENCE STANDARDS

- A. ASTM C1036 - Standard Specification for Flat Glass; 2021.
- B. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016 (Reapproved 2023).
- C. GANA (GM) - GANA Glazing Manual; 2022.
- D. GANA (SM) - GANA Sealant Manual; 2008.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data on Mirror Types: Submit structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- C. Samples: Submit two samples, 12 x 12 inch in size, illustrating mirrors design, edging, and coloration.
- D. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA (GM), GANA (SM), and _____ for glazing installation methods.
- B. Fabricate, store, transport, receive, install, and clean mirrors in accordance with manufacturer's recommendations.

1.5 FIELD CONDITIONS

- A. Do not install mirrors when ambient temperature is less than 50 degrees F.
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.6 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for reflective coating on mirrors and replacement of same.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Mirror Design Criteria: Select materials and/or provide supports as required to limit mirror material deflection to 1/200, or to the flexure limit of glass, with full recovery of glazing materials, whichever is less.
- B. Mirror Glass: Clear, annealed float glass; ASTM C1036, with copper and silver coatings, and protective overcoating.
 - 1. Thickness: 1/4 inch.

2. Size: As indicated on drawings.

2.2 ACCESSORIES

- A. Setting Blocks: Neoprene, 80 to 90 Shore A durometer hardness.
- B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness.
- C. Glazing Tape: Preformed butyl compound; 10 to 15 Shore A durometer hardness; on release paper.
- D. Mirror Attachment Accessories: Stainless steel J-profile channels.
- E. Mirror Adhesive: Silicone pre-polymer based, chemically compatible with mirror coating and wall substrate.
 1. Application Temperature: Minus 35 to 140 degrees F at contact surfaces.
 2. Volatile Organic Content (VOC): Less than 7 percent by weight.

2.3 FABRICATION

- A. Cutouts: Fabricate cutouts before tempering for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.
- B. Mirror Edge Treatment: Flat polished. Seal edges of mirrors with edge sealer.
- C. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint as recommended in writing by film-backing manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that openings for mirrored glazing are correctly sized and within tolerance.
- B. Verify that surfaces of mirror frames or recesses are clean, free of obstructions, and ready for installation of mirrors.

3.2 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
- B. Seal porous mirror frames or recesses with substrate compatible primer or sealer. Prime surfaces scheduled to receive sealant.
- C. Prepare installation in accordance with ASTM C1193 for solvent release sealants, and install sealant in accordance with manufacturer's instructions.

3.3 INSTALLATION

- A. Install mirrors in accordance with manufacturer's recommendations.
- B. Set mirrors plumb and level, and free of optical distortion.
- C. Set mirrors with edge clearance free of surrounding construction including countertops or backsplashes.
- D. Wall-Mounted Mirrors: Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.

3.4 CLEANING

- A. Remove wet glazing materials from finish surfaces.
- B. Remove labels after work is complete.
- C. Clean mirrors and adjacent surfaces.

END OF SECTION 08 83 00

SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Performance criteria for gypsum board assemblies.
- B. Resilient sound isolation clips.
- C. Acoustic insulation.
- D. Backing board for wall tile.
- E. Gypsum wallboard.
- F. Joint treatment and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 05 40 00 - Cold-Formed Metal Framing: Structural steel stud framing.
- B. Section 06 10 00 - Rough Carpentry: Building framing and sheathing.
- C. Section 07 84 00 - Firestopping: Top-of-wall assemblies at fire-resistance-rated walls.
- D. Section 07 92 00 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.
- E. Section 09 22 16 - Non-Structural Metal Framing.
- F. Section 09 30 00 - Tiling: Tile backing board.

1.3 REFERENCE STANDARDS

- A. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).
- B. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.
- C. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2023.
- D. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2022.
- E. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.
- F. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.
- G. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.
- H. ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels; 2023.
- I. ASTM C1658/C1658M - Standard Specification for Glass Mat Gypsum Panels; 2019, with Editorial Revision (2020).
- J. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.
- K. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
- L. ASTM E413 - Classification for Rating Sound Insulation; 2022.
- M. GA-216 - Application and Finishing of Gypsum Panel Products; 2021.
- N. UL (FRD) - Fire Resistance Directory; Current Edition.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of gypsum board assemblies with size, location, and installation of service utilities.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide data on gypsum board, accessories, and joint finishing system.
- C. Shop Drawings: Indicate special details associated with fireproofing and acoustic seals.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C840 requirements, GA-216 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. 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.
- C. **Do not finish** interior products until installation areas are enclosed and controlled for temperature, humidity and ventilation by either temporary or permanent means.

PART 2 PRODUCTS

2.1 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
 - 1. See PART 3 for finishing requirements.
- B. Interior Partitions, Indicated as Acoustic: Provide completed assemblies with the following characteristics:
 - 1. Acoustic Attenuation: STC as indicated calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- C. Fire-Resistance-Rated Assemblies: Provide completed assemblies complying with applicable code.
 - 1. Fire-Resistance-Rated Partitions: UL listed assembly No. ____; ____ hour rating.
 - 2. Fire-Resistance-Rated Ceilings and Soffits: One (1) hour fire rating.
 - 3. UL Assembly Numbers: Provide construction equivalent to that listed for the particular assembly in the current UL (FRD).
- D. Quality: Comply with ASTM C 36/C 36M or ASTM C1396/C1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
- E. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.2 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
 - 1. American Gypsum Company: www.americangypsum.com/#sle.
 - 2. CertainTeed Corporation: www.certainteed.com/#sle.
 - 3. Georgia-Pacific Gypsum: www.gpgypsum.com/#sle.
 - 4. Gold Bond Building Products, LLC provided by National Gypsum Company: www.goldbondbuilding.com/#sle.
 - 5. USG Corporation: www.usg.com/#sle.
 - 6. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; provide maximum sizes to minimize joints in place; ends square cut.
 - 1. Application: As indicated on drawings.
 - 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - a. Mold resistant board is required on any wall surfaces in toilet rooms or janitor closets where a tile is not applied, and behind drinking fountain walls.
 - 3. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 - 4. Thickness:
 - a. Vertical Surfaces: 5/8 inch, unless noted otherwise.
 - b. Ceilings: 5/8 inch, unless noted otherwise.
 - c. Multi-Layer Assemblies: Thicknesses as indicated on drawings.
 - 5. Edges: Tapered
- C. Abuse Resistant Wallboard:
 - 1. Application: High-traffic areas indicated.
 - 2. Surface Abrasion: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M.
 - 3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 4. Type: Fire-resistance-rated Type X, UL or WH listed.
 - 5. Thickness: 5/8 inch.
 - 6. Edges: Tapered.
- D. Exterior Sheathing Board: See Section 06 10 00.

2.3 GYPSUM BOARD ACCESSORIES

- A. Acoustic Insulation: ASTM C665; preformed mineral-fiber, friction fit type, unfaced; thickness 2 inches.
- B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
- C. Finishing Accessories: ASTM C1047, extruded aluminum alloy (6063 T5) or galvanized steel sheet ASTM A924/A924M G90, unless noted otherwise.
 - 1. Material: **Plastic trim is not allowed unless otherwise noted.**
 - 2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. L-Bead: L-shaped; exposed long flange receives joint compound.
 - d. U-Bead: **Not allowed unless otherwise noted.**

- e. Expansion (control) joint.
- D. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Fry Reglet Corporation; or comparable product by one of the following:
 - a. Fry Reglet Corporation.
 - 2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221, Alloy 6063-T5.
 - 3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified Manufacturer's standard factory spray and bake-on primer to serve as a base for field painting.
 - a. "F" Reveal (Size/Model #): 1/2" / DRMF-625-50, 3/4" / DRMF-625-75, unless noted on the drawings.
 - b. "Z" Reveal (Size/Model #): 1/2" / DRMZ-625-50, and 3/4" / DRMZ-625-75 unless otherwise noted on the drawings.
 - c. "Plaster Key Reveal Molding"; PRZ-75-100
 - d. "L" Trim Molding (Size / Model #): 1 1/2" / DRML-150, 5/8" / DRML-625, and 3" / DRML-300.
 - e. "J" Trim Molding (Size / Model #): 5/8" / JDM-625
 - f. "Drywall Reveal Molding" (Size / Model #): 1/2" / DRM-625-50.
- E. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
 - 1. Joint Tape:
 - a. Interior Gypsum Board: Paper.
 - b. Exterior Gypsum Soffit Board: Paper.
 - c. Tile Backing Panels: As recommended by panel manufacturer.
 - 2. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 - a. Pre-filling: At open joints and damaged surface areas, use setting-type taping compound.
 - b. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
 - 1) Use setting-type compound for installing paper-faced metal trim accessories.
 - c. Fill Coat: For second coat, use drying-type, all-purpose compound.
 - d. Finish Coat: For third coat, use drying-type, all-purpose compound.
 - 3. Joint Compound for Tile Backing Panels:
 - a. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
 - b. Cementitious Backer Units: As recommended by backer unit manufacturer.
 - c. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.
- F. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.
- G. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion-resistant.

2.4 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

- B. **Sound-Attenuation Blankets:** ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
 - 2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than percent.
- C. **Acoustical 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. Manufacturers: Subject to compliance with requirements, provide one of the following or a comparable product:
 - a. United States Gypsum (USG), Chicago, IL – www.usg.com
 - b. Hilti (Hilti), Tulsa, OK – www.hilti.com
 - c. 3M (3M), St. Paul, MN – www.3m.com
 - d. Pecora (Pecora), Harleysville, PA – www.pecora.com
 - e. Tremco (Tremco), Toronto, Ontario, Canada – www.tremco.com
 - 2. Verify sealant has a VOC content of 250 g/L or less.
 - 3. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- D. **Acoustical partition closure:** Basis-of-Design: Subject to compliance with requirements, provide Mullion Mate® - Partition Gap Closures manufactured by Gordon, Inc. For all inquiries contact:
 - 1. Gordon, Inc. 5023 Hazel Jones Road Bossier City, LA 71111 (800) 747-8954 sales@gordon-inc.com
 - 2. Materials:
 - a. Aluminum extrusions: 6063-T5 or T6 temper, tensile strength 31 KSI (ASTM B 221, ASTM B 221M). Specify Mullion Mate® 2.
 - b. Opening Size: Provide appropriate Series based on opening size required per the drawings to close the opening and the STC rating required.
 - c. Length: Full height with no joints.
 - d. Finish: Factory-Clear Anodized
 - 3. Accessories:
 - a. Mullion Mate® End Caps – Specify Extruded MMEC.
 - b. Size: See drawings.
 - c. Length: Full height with no joints.
 - d. Corrosion-resistant primer compatible with joint compound and powder coated to match wall color.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.
- B. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.

- C. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Acoustic Sealant: Install in accordance with manufacturer's instructions.
 - 1. Place one bead continuously on substrate before installation of perimeter framing members.
 - 2. Place continuous bead at perimeter of each layer of gypsum board.
 - 3. Seal around all penetrations by conduit, pipe, ducts, and rough-in boxes, except where firestopping is provided.
- C. Sound Barrier Mullion Trim Cap Installation: Install in accordance with manufacturer's instructions for installation of fire-rated mullion trim caps.

3.3 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- 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 of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. 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 wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4 to 1/2 inch wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. Gypsum Board Finish Levels: Finish panels to levels indicated below and in accordance with ASTM C840:
 - 1. 1. Level 1: Embed tape at joints in ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies. Ceiling plenum areas, concealed areas, and where indicated.
 - a. Level 1: Finish shall be applied at ceiling plenum areas, concealed areas.
 - 2. Level 2: Not used.

3. Level 3: Embed tape and apply separate first and fill coats of joint compound to tape, fasteners, and trim flanges. Joint compound shall be smooth and free from tool marks and ridges. .
 - a. Level 3: Finish shall be applied to panels in Mechanical Rooms, Electrical Rooms, and similar spaces, or as indicated in Drawings.
4. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges. Joint compound shall be smooth and free from tool marks and ridges. At panel surfaces that will be exposed to view unless otherwise indicated .
 - a. Level 4: Finish shall be applied to panels in all locations except where another level of finish is specified.
 - b. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."
5. Level 5: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges, and apply skim coat of joint compound over entire surface where indicated.
 - a. Level 5: Where indicated on Drawings.
 - b. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."

3.4 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Nonrated: Install gypsum board parallel to framing, with ends and edges occurring over firm bearing unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 1. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 2. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
- C. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
- D. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- E. Fire-Resistance-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- F. Exposed Gypsum Board in Interior Wet Areas: Seal joints, cut edges, and holes with water-resistant sealant.

3.5 INSTALLATION OF TRIM AND ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Place control joints consistent with lines of building spaces and as indicated. If not indicated review with Architect before placing.
 1. Not more than 20 feet apart on walls and ceilings over 20 feet long.
 2. At exterior soffits, not more than 30 feet apart in both directions.
- C. Corner Beads: Install at external corners, using longest practical lengths.
- D. Interior Trim: Install in the following locations:
 1. Cornerbead: Use at outside corners, unless otherwise indicated.
 2. LC-Bead: Use at exposed panel edges.
 3. L-Bead: Use where indicated.

3.6 TOLERANCES

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

3.7 CLEANING

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

3.8 PROTECTION

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

END OF SECTION 09 21 16

SECTION 09 22 16
NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Non-load-bearing Metal framing for interior partition, ceiling, and soffit framing.
- B. Framing accessories.

1.2 RELATED REQUIREMENTS

- A. Section 05 40 00 - Cold-Formed Metal Framing: Requirements for structural, load-bearing, metal stud framing and exterior wall stud framing.
- B. Section 05 40 00 - Cold-Formed Metal Framing: Execution requirements for anchors for attaching work of this section.
- C. Section 09 21 16 - Gypsum Board Assemblies: Metal studs for gypsum board partition framing.

1.3 REFERENCE STANDARDS

- A. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing; 2020.
- B. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing; 2015, with Errata (2020).
- C. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2019.
- D. ASTM A645/A645M - Standard Specification for Pressure Vessel Plates, 5 % and 51 2 % Nickel Alloy Steels, Specially Heat Treated; 2010 (Reapproved 2022).
- E. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2018.
- F. ASTM D226/D226M - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing; 2017 (Reapproved 2023).
- G. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.
- H. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2023.
- I. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
- J. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.
- K. ASTM E413 - Classification for Rating Sound Insulation; 2022.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: For each type of product.
- C. 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.
- D. Product Certificates: For each type of code-compliance certification for studs and tracks.
- E. Evaluation Reports: For high-strength steel studs and tracks, post-installed anchors, and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

- A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to a product-certification program.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Notify manufacturer of damaged materials received prior to installation.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing."

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Metal Framing, Connectors, and Accessories:
 - 1. ClarkDietrich: www.clarkdietrich.com/#sle.
 - 2. MarinoWARE: www.marinoware.com/#sle.
 - 3. Simpson Strong Tie: www.strongtie.com/#sle.
 - 4. The Steel Network, Inc: www.SteelNetwork.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 FRAMING MATERIALS

- 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, in accordance with 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 on Drawings, in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.
- C. Loadbearing Studs: As specified in Section 05 40 00.
- D. Non-Loadbearing Framing System Components: AISI S220; sheet steel, of size and properties necessary for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf.
- E. Framing Members, General: Comply with ASTM C754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
 - 2. Corrosion Protection Coating Designation: CP 60 (G60, A60, or AZ50) in accordance with AISI S240.
- F. Studs and Tracks: ASTM C645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.
 - 1. Steel Studs and Tracks:
 - a. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection and 22 GA minimum.
 - b. Depth: As indicated on Drawings.
- G. Slip-Type Head Joints: Where indicated, provide one of the following:
 - 1. Single Long-Leg Track System: ASTM C645 top track with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.

2. Double-Track System: ASTM C645 top outer tracks, inside track with 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
3. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- H. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- I. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 1. Minimum Base-Steel Thickness: 0.0269 inch thickness.
- J. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch-wide flanges.
 1. Depth: 1-1/2 inches.
 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches , 0.068-inch- thick, galvanized steel.
- K. Hat-Shaped, Rigid Furring Channels: ASTM C645.
 1. Minimum Base-Steel Thickness: 0.0296 inch.
 2. Depth: As indicated on Drawings, 7/8 inch minimum.
- L. Resilient Furring Channels: 1/2-inch and 1 inch-deep, steel sheet members designed to reduce sound transmission.
 1. Configuration: Asymmetrical
- M. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges.
 1. Depth: As shown.
 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch.
 3. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- N. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-steel thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

2.3 FABRICATION

- A. Fabricate assemblies of framed sections to sizes and profiles required.
- B. Fit, reinforce, and brace framing members to suit design requirements.

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide the following:
 1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.

3.2 PREPARATION

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

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLATION OF STUD FRAMING

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
 - 2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
 - 3. Tile Backing Panels: As required by horizontal deflection performance requirements, typically 16 inches o.c. unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks 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 that penetrate 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 jamps to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
6. Curved Partitions:
 - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.
- E. Direct Furring:
 1. Screw to wood framing.
 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- F. Z-Shaped Furring Members:
 1. Erect insulation, specified in Section 07 21 00 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches o.c.
 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- G. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
- H. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.
- I. Blocking: Use wood blocking secured to studs. Provide blocking for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, hardware, opening frames, and where indicated per the Drawings.

3.5 CEILING AND SOFFIT FRAMING

- A. Install furring after work above ceiling or soffit is complete. Coordinate the location of hangers with other work.
- B. Install furring independent of walls, columns, and above-ceiling work.
- C. Securely anchor hangers to structural members or embed them in structural slab. Space hangers as required to limit deflection to criteria indicated. Use rigid hangers at exterior soffits.
- D. Space main carrying channels at maximum 72 inches on center, and not more than 6 inches from wall surfaces. Lap splice securely.
- E. Securely fix carrying channels to hangers to prevent turning or twisting and to transmit full load to hangers.
- F. Place furring channels perpendicular to carrying channels, not more than 2 inches from perimeter walls, and rigidly secure. Lap splices securely.

3.6 TOLERANCES

- A. Maximum Variation From True Position: 1/8 inch in 10 feet.
- B. Maximum Variation From Plumb: 1/8 inch in 10 feet.

END OF SECTION 09 22 16

**SECTION 09 30 00
TILING**

PART 1 GENERAL

1.1 SECTION INCLUDE

- A. Porcelain wall tile.
- B. Porcelain Floor tile.
- C. Metal edge strips and transitions.

1.2 RELATED REQUIREMENTS

- A. Section 07 92 00 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
- B. Section 09 29 00 "Gypsum Board" for glass-mat, water-resistant backer board.
- C. Section 10 28 00 "Toilet and Bath Accessories" for toilet, bath and shower accessories mounted in tile work.

1.3 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. Face Size: Actual tile size, excluding spacer lugs.
- C. Module Size: Actual tile size plus joint width indicated.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Initial Selection: For tile, grout, and accessories involving color selection.
- D. Samples for Verification:
 - 1. Full-size units of each type and composition of tile and for each color and finish required.
 - 2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 36 inches square, but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.
 - 3. Full-size units of each type of trim and accessory for each color and finish required.
 - 4. Metal edge trims in 6-inch lengths.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Test Reports: For tile-setting and -grouting products and certified porcelain tile.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
 - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer is a Five-Star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
 - 2. Installer's supervisor for Project holds the International Masonry Institute's Foreman Certification.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockup of each type of floor tile installation.
 - 2. Build mockup of each type of wall tile installation.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
 - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
 - 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
 - 2. Obtain waterproof membrane, except for sheet products, from manufacturer of setting and grouting materials.

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
 - 1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

2.3 TILE PRODUCTS

- A. Porcelain Wall Tile Type WF04:
 - 1. [Basis-of-Design Product](#): Subject to compliance with requirements, provide Vivant by Portobello America; www.uniquetile.com; 1-417-725-5515; or comparable product.
 - 2. Wall Finish Type: WF04, see Drawings for location.
 - a. Style: Flat (Smooth).
 - b. Face Size: 3 x 10 inches.
 - c. Thickness: 7.4 mm.
 - d. Tile Color, Glaze, and Pattern: Blanc, Glossy, Vertical Stacked Bond.
 - e. Grout Color: As selected by Architect from manufacturer's full range.
- B. Porcelain Wall Tile Type WF05:
 - 1. [Basis-of-Design Product](#): Subject to compliance with requirements, provide Vivant Ligne by Portobello America; www.uniquetile.com; 1-417-725-5515; or comparable product.
 - 2. Wall Finish Type: WF05, see Drawings for location.
 - a. Style: Ligne (Ribbed).
 - b. Face Size: 3 x 10 inches.
 - c. Thickness: 7.4 mm.
 - d. Tile Color, Glaze, and Pattern: Blanc, Matte, Vertical Stacked Bond.
 - e. Grout Color: As selected by Architect from manufacturer's full range.
- C. Porcelain Wall Tile Type WF20:
 - 1. [Basis-of-Design Product](#): Subject to compliance with requirements, provide Vivant Ligne by Portobello America; www.uniquetile.com; 1-417-725-5515; or comparable product.
 - 2. Wall Finish Type: WF20, see Drawings for location.
 - a. Style: Ligne (Ribbed).
 - b. Face Size: 3 x 10 inches.
 - c. Thickness: 7.4 mm.
 - d. Tile Color, Glaze, and Pattern: Brut, Matte, Vertical Stacked Bond.

- e. Grout Color: As selected by Architect from manufacturer's full range.
- D. Porcelain Floor Tile: See Drawings for location.
 - 1. [Basis-of-Design Product](#): Subject to compliance with requirements, provide Cement Block by Portobello America; www.uniquetile.com; 1-417-725-5515; or comparable product:
 - 2. Size: 12 by 24 inches.
 - 3. Thickness: 8.5 mm.
 - 4. Finish: NAT Bold
 - 5. Tile Color and Pattern: Foggy
 - 6. Grout Color: As selected by Architect from manufacturer's full range.
 - 7. Floor Water Absorption: <0.5%
 - 8. Floor DOCF Wet: >0.42.
 - 9. Chemical Resistant
- E. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Internal Corners: Field-butt square corners.
- F. Metal Trim Units: Provide stainless-steel edge trim in appropriate thickness, finish as selected by Architect from manufacturer's full range.
 - 1. Basis-of-Design Product: Provide JOLLY as manufactured by Schluter Systems L.P., or comparable product of other manufacturers approved by the Architect.
 - a. Locations: At outside corners.

2.4 SETTING MATERIALS

- A. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3., with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
- C. Provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
- D. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Laticrete International, Inc.
 - 2. MAPEI Corporation.
 - 3. Sika Corporation.

2.5 GROUT MATERIALS

- A. Water-Cleanable Epoxy Grout: ANSI A118.3, with a VOC content of 65 g/L or less.
- B. Grout Color: As selected by Architect from manufacturer's full range.
- C. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Laticrete International, Inc.
 - 2. MAPEI Corporation.
 - 3. Sika Corporation.
 - 4. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F, respectively, and certified by manufacturer for intended use.

2.6 MISCELLANEOUS MATERIALS

- A. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.7 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 - 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 - 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION OF CERAMIC TILE

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 - 1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Tile floors in wet areas.
 - b. Tile floors consisting of tiles 8 by 8 inches or larger.
 - c. Tile floors consisting of rib-backed tiles.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
 - 1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
 - 2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 - 3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Porcelain Tile: 3/16" .
- H. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- I. Floor Sealer (non-epoxy grout): Apply floor sealer to cementitious grout joints in tile floors according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove grout residue from tile as soon as possible.

2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.5 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

END OF SECTION 09 30 00

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SECTION 09 51 00
ACOUSTICAL TILE CEILINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.
- C. Metal edge moldings, transitions, and trims.

1.2 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; 2023.
- B. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2022.
- C. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels; 2019.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- E. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.
- F. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2022.
- G. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2023.
- H. NAAMM AMP 500-06 - Metal Finishes Manual; 2006.

1.3 ADMINISTRATIVE REQUIREMENTS

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

1.4 COORDINATION

- A. Sequencing: Coordinate with the work of all trades above the ceiling and penetrating or supported by it. Do not start work until all appropriate work above the ceiling is complete.
- B. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- C. Coordination: Coordinate with electrical, HVAC and fire protection trades to ensure edge configuration of light fixture, air diffusers shade pockets and sprinkler heads to penetrate or to lay in ceilings are proper for the system and provide system layout that accommodates lighting pattern.
 - 1. **Notify Architect of discrepancies immediately.**

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on suspension system components and acoustical units.
- C. Samples: Submit one sample 12 by 12 inch in size illustrating material and finish of each acoustical unit.
- D. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

1.6 QUALITY ASSURANCE

- A. Source Limitations:
 - 1. Acoustical Ceiling Tile: Obtain each type through one source from a single manufacturer.
 - 2. Suspension System: Obtain each type through one source from a single manufacturer.

1.7 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.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical tile ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 - 1. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 68 percent prior to, during, and after acoustical unit installation.

1.9 WARRANTY

- A. Acoustical Panels Manufacturer Warranty: Submit a written warranty executed by manufacturer agreeing to repair or replace acoustical tile that fails or is compromised that was created in and directly attributable to the manufacturer's manufacturing process within the specified warranty period.
 - 1. Warranty Period: **30 years** from date of substantial completion.
- B. Acoustical Panels Manufacturer Warranty: Submit a written warranty executed by manufacturer agreeing to repair or replace acoustical tile that fails or is compromised within the specified warranty period. Failed or compromised parts can include, but are not limited, to rusting (50% red rust as defined by ASTM B-117) or defects directly made by the manufacturer.
 - 1. Warranty Period: **40 years** from date of substantial completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acoustic Tiles/Panels:
 - 1. Basis-of-Design Product: Provide "Ultima" Ceiling System as manufactured by Armstrong Ceiling & Wall Solutions, or comparable product approved by the Architect by one of the following:
 - a. Armstrong World Industries, Inc: www.armstrongceilings.com/#sle.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Suspension Systems:

1. Basis-of-Design Product: Provide Prelude 15/16 inch Suspension System as manufactured by Armstrong Ceiling & Wall Solutions, or comparable product approved by the Architect by one of the following:
 - a. Same as for acoustical units.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Rating: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: Class A in accordance with ASTM E84.
 2. Smoke-Developed Index: 50 or less.

2.3 ACOUSTICAL UNITS

- A. Acoustical Units - General: ASTM E1264, Class A.
- B. Acoustical Panels, Type C1A: Mineral fiber with membrane-faced overlay, with the following characteristics:
 1. Classification: ASTM E1264 Type IV.
 - a. Form: 2, water felted.
 - b. Pattern: "E" - lightly textured.
 2. Size: 24 by 24 inches.
 3. Thickness: 3/4 inch.
 4. Light Reflectance: Not less than 0.80, determined in accordance with ASTM E1264.
 5. NRC Range: 0.75 to 0.85, determined in accordance with ASTM E1264.
 6. Articulation Class (AC): Not less than 170, determined in accordance with ASTM E1264.
 7. Ceiling Attenuation Class (CAC): 35, determined in accordance with ASTM E1264.
 8. Panel Edge: Square.
 9. Color: White.
 10. Suspension System Type 1: Exposed grid.
- C. Acoustical Panels, Type C1B: Mineral fiber with membrane-faced overlay, with the following characteristics:
 1. Application(s): Black Box and Film Studio.
 2. Classification: ASTM E1264 Type IV.
 - a. Form: 2, water felted.
 - b. Pattern: "E" - lightly textured.
 3. Size: 24 by 24 inches.
 4. Thickness: 3/4 inch.
 5. Light Reflectance: Not less than 0.80, determined in accordance with ASTM E1264.
 6. NRC Range: 0.75 to 0.85, determined in accordance with ASTM E1264.
 7. Articulation Class (AC): Not less than 170, determined in accordance with ASTM E1264.
 8. Ceiling Attenuation Class (CAC): 35, determined in accordance with ASTM E1264.
 9. Panel Edge: Square.
 10. Color: Black.
 11. Suspension System Type 2: Exposed grid.
 12. Products:
- D. Acoustical Panels, Type C1C: Mineral fiber with membrane-faced overlay, with the following characteristics:

1. Classification: ASTM E1264 Type IV.
 - a. Form: 2, water felted.
2. Size: 24 by 24 inches.
3. Thickness: 3/4 inches.
4. Light Reflectance: Not less than 0.80, determined in accordance with ASTM E1264.
5. NRC Range: 0.75 to 0.85, determined in accordance with ASTM E1264.
6. Articulation Class (AC): [Not less than 170], determined in accordance with ASTM E1264.
7. Ceiling Attenuation Class (CAC): 35, determined in accordance with ASTM E1264.
8. Panel Edge: Beveled Tegal.
9. Color: White.
10. Suspension System Type 1: Exposed grid.
11. Products:

2.4 SUSPENSION SYSTEM, GENERAL

- A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
 1. Materials:
 - a. Steel Grid: ASTM A653/A653M, G30 coating, unless otherwise indicated.
 2. Finishes and Colors, General: Comply with NAAMM AMP 500-06 "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.

2.5 SUSPENSION SYSTEM(S)

- A. Exposed Suspension System, Type 1: Hot-dipped galvanized steel grid with steel cap.
 1. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
 2. Profile: Tee; 15/16 inch face width.
 3. Finish: Baked enamel.
 4. Color: White.
- B. Exposed Suspension System, Type 2: Hot-dip galvanized steel grid and cap.
 1. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
 2. Profile: Tee; 15/16 inch face width.
 3. Finish: Baked enamel.
 4. Color: Black.
- C. Ceiling Grid Clip
 1. Armstrong World Industries, Inc., "Uptight Clip", or equal for metal suspension grid to cantilever past the soffit wall.
- D. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, G30 (Z90) coating designation.
 1. Structural Classification: Intermediate-duty system.
- E. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with aluminum complying with ASTM C635 Severe Environmental Performance (Wet Rated system)
 1. Structural Classification: Intermediate-duty system.

2.6 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
 - 1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing in accordance with ASTM E488/E488M or ASTM E1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: Postinstalled expansion Postinstalled bonded anchors.
 - b. Corrosion Protection, Carbon Steel: Components zinc plated in accordance with ASTM B633, Class SC 1 (mild) service condition.
 - c. Corrosion Protection, Stainless Steel: Components complying with ASTM F593 and ASTM F594, Group 1 Alloy 304 or 316.
 - d. Corrosion Protection, Nickel-Copper Alloy: Components fabricated from nickel-copper-alloy rods complying with ASTM B164 for UNS No. N04400 alloy.
 - 2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing in accordance with ASTM E1190, conducted by a qualified testing and inspecting agency.
- C. Wire Hangers, Braces, and Ties: Provide wires as follows:
 - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
 - 2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.135-inch- diameter wire.
- D. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
 - 1. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- E. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch- thick, galvanized-steel sheet complying with ASTM A653/A653M, G90 coating designation; with bolted connections and 5/16-inch- diameter bolts.
- F. Hold-Down Clips: Manufacturer's standard clips to suit application.
- G. Seismic Clips: Manufacturer's standard clips for seismic conditions and to suit application.

2.7 METAL EDGE MOLDINGS, TRANSITIONS, AND TRIMS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
- B. a. Pre-mitered corners
- C. Extruded Aluminum Edge Molding:
 - 1. Ceiling Trim Type 1: Armstrong World Industries, Inc.; 2" nominal Depth Axiom Classic edge trim, or equal for ACT ceilings.
 - a. Pre-mitered corners
 - b. Color: As selected by the Architect from the manufacturer's full range of colors.
 - c. T-Bar Connector Clip-XTBC to allow tiles to be accessible at perimeter.
 - d. Install edge molding at perimeter of "floating ceilings", and at locations where ceiling does not extend to face of wall.

2. Ceiling Trim Type 5: Armstrong World Industries, Inc., Axiom Trims for Drywall, or equal.
 - a. Extruded aluminum.
 - b. Size: 2 1/2" -One-piece trim for drywall, straight.
 - c. Color: As selected by the Architect from the manufacturer's full range of colors.
3. Ceiling Trim Type 6: Armstrong World Industries, Inc., Axiom Knife Edge Trim Straight for drywall, or equal.
 - a. Pre-engineered vertical trim compatible with 5/8" Drywall.
 - b. Size: Straight 120 x 6 x 5 inches.
 - c. Color: As selected by the Architect from the manufacturer's full range of colors.
- D. Extruded Aluminum Panel Transitions
 1. Ceiling Trim Type 2: Armstrong World Industries, Inc., Straight transition panels, or equal at changes in ceiling height.
 - a. Height: 6 inches or as indicated in the drawings.
 - b. Types Required: ACT to GWB Axiom Drywall Bottom trim required.
 - c. Color: As selected by the Architect from the manufacturer's full range of colors.
- E. Transition Molding: Drywall to Acoustical ceiling.
 1. Ceiling Trim Type 3: Armstrong World Industries, Inc., "9/16" F Vertical Shadow Reveal Transition Molding", or equal.
 - a. Hot dipped cold rolled steel.
 - b. Pre-Painted White integral acoustical flange and drywall taping flange
 - c. KAM angle at top of transition.
 2. Ceiling Trim Type 4: Armstrong World Industries, Inc., "9/16" Tegular Transition Molding", or equal – for flush conditions.
 - a. Hot dipped cold rolled steel.
 - b. Pre-Painted White integral acoustical flange and drywall taping flange.
- F. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
- G. 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.
 1. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- H. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which acoustical tile ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 1. Verify that layout of hangers will not interfere with other work.

- B. Examine acoustical tiles before installation. Reject acoustical tiles that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Install after major above-ceiling work is complete.
- B. Coordinate the location of hangers with other work.
- C. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders unless otherwise indicated, and comply with layout shown on **reflected ceiling plans**.
- D. Provide hanger clips during steel deck erection. Provide additional hangers and inserts as required.

3.3 INSTALLATION

- A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 5. 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.
 - 6. Do not attach hangers to steel deck tabs.
 - 7. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 - 8. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- D. Locate system on room axis according to reflected plan.
- E. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Use longest practical lengths.
- F. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- G. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

- H. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- I. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- J. Do not eccentrically load system or induce rotation of runners.
- K. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
 - 1. Arrange directionally patterned acoustical panels as follows:
 - a. As indicated on reflected ceiling plans.
 - 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
 - 3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 - 4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
 - 5. Re-tregular and paint all cut edges of tegular ceiling tiles.
 - 6. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
 - 7. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions unless otherwise indicated.

3.4 TOLERANCES

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

3.5 CLEANING

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

END OF SECTION 09 51 00

SECTION 09 58 13
MONOLITHIC ACOUSTICAL CEILING SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Suspension systems for perforated gypsum interior ceilings and soffits.
- B. Acoustical Insulation for perforated gypsum board ceilings.
- C. Extruded aluminum trim for ceiling height changes and material transitions.

1.2 RELATED REQUIREMENTS

- A. Section 09 22 16 - Non-Structural Metal Framing: panelized and field erected non-structural steel framing components, unless otherwise noted, to support work of this section.

1.3 REFERENCE STANDARDS

- A. ASTM C840 - Standard Specification for Application and Finishing Gypsum Board; 2023.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Subcontractor is an experienced Installer, approved and trained by product manufacturer to properly install ceiling system.
 - 1. Subcontractor shall provide documentation that they are certified installers.
 - 2. Subcontractor shall utilize approved equipment and procedures for proper installation.
- B. Source Limitations: Obtain monolithic acoustical ceiling system from single manufacturer.

1.6 COORDINATION

- A. Pre-installation conference: Conduct conference at project site.
 - 1. Review the coordination of all luminaires, sprinklers, exit signs and MEP devices that are to be installed in the ceiling.
- B. Coordinated Shop Drawings: Contractor shall submit coordinated shop drawings that clearly indicate the following components for Architect Approval prior to installation.
- C. Shop drawings shall include device alignment, dimensions, center lines and indicate the following:
 - 1. Access panels.
 - 2. Ceiling devices.
 - 3. Ceiling framing.
 - 4. Changes in ceiling height elevation.
 - 5. Control joints
 - 6. Drywall edge profile and associated splice clips for vertical joints.
 - 7. Life safety devices.
 - 8. Light fixtures.
 - 9. MEP grilles.
 - 10. Miscellaneous items located on ceiling.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original, unopened packaging and store in an enclosed shelter providing protection from damage and exposure to the elements.
 - 1. Store within temperature limits required by manufacturer.
 - 2. Store gypsum board panels flat.
 - 3. Comply with manufacturer's requirements for safety and handling.
- B. Discard joint compounds and sealants that cannot be applied within their stated shelf life.
- C. Store accessory materials in a location with constant ambient temperatures of 50 to 80 °F (15 to 27 °C). Avoid exposure to sustained temperatures exceeding 125 °F (52 °C).

1.8 FIELD CONDITIONS

- A. Install monolithic acoustical ceiling system in an indoor environment that is climate controlled.
- B. Comply with ASTM C840 requirements for interior drywall installation: Maintain room temperatures at greater than 40 °F (4.4 °C) at least 48 hours before panel installation and greater than 50 °F (10 °C) at least 48 hours before joint treatment or spray-applied finish application, and continuously during and after application.
- C. Avoid exposure and protect from excessive, repetitive or continuous moisture before, during and after installation. Eliminate sources of moisture immediately.
- D. Adequate ventilation shall be maintained in the working area during installation and curing period.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

2.2 MONOLITHIC SOUND ABSORBING GYPSUM BOARD SYSTEM

- A. Sound Absorbing Gypsum Ceiling and Framing System: Ceiling Type C2A.
 - 1. Basis of Design: Subject to compliance with project requirements, provide USG Interiors, LLC, "USG ENSEMBLE® ACOUSTICAL DRYWALL SYSTEM" or comparable product.
- B. Perforated Gypsum Board for Ceiling application.
 - 1. Perforated non-fire rated gypsum board with acoustically transparent scrim complies with ASTM C1396 Non-type X.
 - 2. Subject to compliance with project requirements, the design is based on the following: USG Corporation, LLC, "USG Sheetrock® Brand Ensemble® Four-Sided Taper™ Perforated Gypsum Panels 5/8"
- C. Acoustical Backer Panel: USG Interiors, LLC, "USG Ensemble™ High-NRC Backer Panel".
 - 1. Classification: Provide un-faced acoustical panels with the following physical attributes:
 - a. NRC: Not less than 0.80.
 - b. CAC: Not less than 40.
 - c. Light Reflectance of 0.85.
 - d. Edge/Joint Detail: SQ Square.
 - e. Panel Thickness: 1 inch (25.4 mm)
 - f. Modular Size: 23.5 by 48 inches (596.9 by 1220 mm).
 - g. Recycled Content: Not less than 66%.

2. High Recycled Content Product: Classified as containing greater than 50% total recycled content. Total recycled content is based on product composition of post-consumer and pre-consumer post-industrial recycled content per FTC guidelines.
3. VOC Emissions: Meets CA Specification 01350, CHPS listed for low emitting materials.

2.3 STEEL FRAMING FOR HORIZONTAL AND ANGLED CEILING SUSPENDED PANELS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 1. Protective Coating: ASTM A 653/A 653M, G40, hot dip galvanized unless otherwise indicated.
- B. Perforated Gypsum Board suspension system complies with applicable requirements per ASTM C 645, direct-hung system.
- C. Framing System:
 1. Deflection criteria: L/240 per ASTM C635.
 2. Galvanized Steel: G40 double-web tee, hot-dipped galvanized steel.
 3. HORIZONTAL AND ANGLED CEILING Framing Members:
 - a. USG Drywall Suspension system main tees: DGLW26.
 - b. USG Drywall Suspension system 4' cross tees: DGLW-424
 4. Attachment devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements, if applicable.
 5. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 - a. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 - b. Size: Minimum 12 gage per ASTM C636.

2.4 CEILING PANEL JOINT TREATMENT

- A. Perforated Gypsum Board Joint Treatment.
 1. General: Comply with ASTM C 475/C 475M, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board:
 - a. USG Sheetrock® Brand Easy Sand™ Joint Compound
 - b. USG Sheetrock® Brand Paper Joint Tape.
 - c. USG Sheetrock® Brand All Purpose Joint Compound
 - d. USG Sheetrock® Brand Ensemble™ Ceiling Compound
 2. Application:
 - a. Joint Compound for Interior Gypsum Board: For each coat, use formulation that complies with USG Ensemble® Acoustical Monolithic Ceiling System applied on previous and or successive coats.
 3. Prefilling:
 - a. At open joints or beveled panel edges, use USG Sheetrock® Brand Easy Sand™ Joint Compound.
 4. Embedding and First Coat:
 - a. For embedding tape, use USG Sheetrock® Brand All Purpose Joint Compound and embed USG Sheetrock® Brand Paper Joint Tape.
 5. Finish Coat:
 - 1) For finish coats on joints, fasteners, and trim flanges, as well as all 3 finish coats over joint tape, use USG Sheetrock® Brand Ensemble™ Ceiling Compound. Finish to create a final coat equal to a Level 4 finish. DO NOT SKIM COAT OVER PERFORATIONS.

2.5 CEILING PANEL SPRAY-APPLIED FINISH

- A. Acoustically Transparent Finish:
 - 1. USG Interiors, LLC, "USG Ensemble™ Spray-Applied Finish":
 - a. Finish: Fine Finish.
 - b. Color: White
 - 2. Classification: Provide acrylic based spray-applied finish complying with USG Ensemble™ Spray-Applied Finish.

2.6 ACCESSORIES

- A. Gypsum Board Trim Accessories.
 - 1. Trim Accessories: Galvanized steel sheet per ASTM 1047: Provide manufacturer approved and tested metal trim that is chemically compatible with the specified ceiling system.
 - a. USG Sheetrock Brand Metal Trim:
 - b. Corner Bead
 - c. Reveal Joint
 - d. L Bead
 - e. U Bead
 - f. Control Joint
 - g. USG Sheetrock® Brand Paper Faced Metal Trim.
- B. Extruded-Aluminum Edge Moldings and Trim.
 - 1. Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following: Provide manufacturer approved and tested metal trim that is chemically compatible with the specified ceiling system.
 - a. Fry Reglet "Z" Reveal.
 - 1) Size / Model #: ¾"; DRMZ-625-75 unless otherwise noted on the drawings.
 - 2) Finish: Powder coated to match wall color.
 - 3) Location: Perimeter of ceiling, see reflected ceiling plans.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas, verify that installed building services to not interfere with work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (610 mm) O.C.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install framing and accessories plumb, and true to line, with connections securely fastened.
- C. Install drywall suspension grid framing, and blocking to support fixtures, equipment services, demountable partition supports, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. This product system installation is similar to a conventional drywall installation. However, there are some differences in both materials and methods of installation that make this system unique. Installers should review and follow all directions of this installation instruction guide.
- F. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMING SYSTEM

- A. Suspended System
 1. Determine the finished ceiling height. If the ceiling extends to the sidewalls, screw attach DGWM24 wall angle to the sidewalls at 5/8" above the finished ceiling height. Fasteners must be in the framing members. Attach hanger wires to structure above using the appropriate method. Hanger wires shall be spaced 48" OC max in each direction. Using pliers, bend the hanger wires.
 2. Insert the hanger wires through the utility holes in the DGLW26 Main Tees. The DGLW26 Main Tees will run perpendicular to the cross tees at 48" OC max. The hanger wires must be within 5 degrees of plumb. Secure the DGLW-424 cross tees to the DGLW26 Main Tees by snapping the clip into the cross-tee holes on the main tee.
 3. The cross tees can be spaced at 16" or 24" OC. If the ceiling extends wall to wall, square up the main tees and screw attach to the DGWM24 wall angle.
 4. Insert the hanger wires through the utility holes in the curved main tees. The curved main tees will run perpendicular to the cross tees at 48" OC max. The hanger wires must be within 5 degrees of plumb. Secure the DGLW-424 cross tees to the curved main tees by snapping the clip into the cross-tee holes on the main tee.
 5. Space the cross tees at 16" OC. If the ceiling extends wall to wall, square up the main tees and screw attach to the DGWM24 wall angle.

3.5 INSTALLING OF HIGH NRC BACKER PANELS

- A. Suspended System and Curved System

1. For high NRC system performance, lay the USG Ensemble® High-NRC Backers in the framing system from above. The acoustical backers are 15.5" x 47.75" or 23.5" x 47.75" and lay on the back of the flanges of the main tees. Installation is similar to standard lay-in ceiling panels. Do not screw attach USG Ensemble® High-NRC Backers panels to the main tees.

3.6 INSTALLATION OF PERFORATED GYPSUM BOARD

- A. Suspended System
- B. The USG Sheetrock® Brand Ensemble® Four-Sided Taper™ Panels can be cut like standard Sheetrock wallboard panels using a T square and utility knife. Score the face of the panels at the desired length, making sure to cut completely through the fiberglass face scrim. Snap the panels and then cut completely through the back scrim. No marks can be made in the field of the panels unless they are covered by USG Sheetrock® brand Ensemble™ Ceiling Compound prior to spraying. (I.e., pencil, marker, or similar).
- C. Fasten the perforated panels parallel to the DWSS Main Tees with screw spacing at 12" OC in the field and 8" OC on the butt ends using 1-1/4" fine thread bugle head drywall screws. The fasteners must be in the field of the board, not the perforations. The fastener head should be just below the surface without tearing the fiberglass scrim.
 1. Tip: Break all butt joints on DWSS Cross Tees and avoid breaking panel joints on the DWSS Main Tees.
- D. A router or keyhole saw can be used to cut penetrations like standard wallboard.
- E. Install beads and trims using the same method as standard wallboard. If the ceiling design is a floating island, trim the perimeter using USG Compäso™ Elite for Drywall.

3.7 JOINT FINISHING

- A. The joints are finished using the USG Sheetrock® Brand All Purpose Joint Compound, Sheetrock® Brand Paper Joint Tape, and USG Sheetrock® Brand Ensemble™ Ceiling Compound. It is imperative to finish the joints as flat and level with the surface of the board as possible. Even slightly hollow or crowned joints will show as imperfections under critical lighting after the finish is applied.
- B. Embed joint tape with the USG Sheetrock® Brand All Purpose Joint Compound. This can be done by hand with a joint knife, or a standard bazooka. Wipe excess joint compound with a joint knife and allow to dry completely.
- C. Spot all fastener heads with USG Sheetrock® Brand Ensemble™ Ceiling Compound using a 1" or 2" joint knife. Keep the compound area small to minimize covering the perforations.
- D. After the bed and tape coat is dry, apply a second coat of USG Sheetrock® Brand Ensemble™ Ceiling Compound on all the fasteners. Then apply the fill coat of USG Sheetrock® Brand Ensemble™ Ceiling Compound over the joints. This can be done using an 8" joint knife or an 8" flat box with the blade set flat.
- E. After the fill coat is dry, apply a third coat of USG Sheetrock® Brand Ensemble™ Ceiling Compound on all the fasteners. Then apply the finish coat of USG Sheetrock® Brand Ensemble™ Ceiling Compound over the joints. This can be done using a 10" joint knife or a 10" flat box with the blade set for a slight crown.
- F. All joints must be filled and leveled with the surface of the board. Hollow joints require additional USG Sheetrock® Brand Ensemble™ Ceiling Compound and crowned joints must be sanded level using a flat sander. It is important to thoroughly check each joint down the entire length for flatness, not just at a few random locations.
- G. A light sanding of the entire surface will help prep for the spray process but avoid over sanding the fiberglass scrim as much as possible.

3.8 SPRAY-APPLIED FINISH

- A. Note: The proper spray equipment must be used to achieve acoustical performance and esthetics.

- B. Please contact your local USG Contractor Specialty Representative for specifications of required spray equipment to apply Ensemble™ Spray-Applied Finish.
- C. Mask off all areas that need protecting from overspray with plastic sheathing. Use a floor protector as required. Set up the spray machine and compressor using the proper hoses. Set the air and material pressure to achieved desired finish.
- D. The USG Ensemble™ Spray-Applied Finish must be mixed in the 5-gallon bucket prior to filling spray machine hopper. Use a 450-rpm electric drill and a USG Sheetrock® 4-blade mixing paddle, blend until it is a smooth creamy consistency. Before any water is added, check the viscosity using a material thickness gauge provided by the spray equipment manufacturer (small steel ball on a cable). Place the ball on the Finish and let go, if the ball sinks into the Finish and is no longer visible in three seconds the material is ready to put in the sprayer. If the ball is still visible after three seconds, add water in 4-ounce increments and remix until the ball sinks in three seconds.
- E. Prime sprayer equipment with 5 gallons of clean potable water. With the nozzle air off, cycle water through the hose and spray gun back into the hopper for 30 seconds and then drain out the water out of the hopper. Pour the 5 gallons of mixed finish into the hopper. With the nozzle air still off, cycle the remaining water out of the hose into a separate container. When the spray finish has reached the gun, cycle the spray finish through the hose and gun back into the hopper until it is flowing smoothly through the machine.
- F. The Ensemble™ Spray-Applied Finish must be applied in a minimum of four coats to achieve the proper appearance and sound performance. Apply each coat very lightly with 36" minimum gun clearance. Start in one corner and work progressively across the ceiling. Immediately cross hatch. Once the finish is dry to the touch (approx. 20-40 min), use a soft rubber squeegee trowel to remove loose Finish, then recoat using the same technique. Apply successive coats until the desired appearance is achieved and the perforations are no longer visible through the Finish.
- G. Maintain proper jobsite conditions and wear proper protective equipment (safety goggles, NIOSH-approved respirator, coveralls) while applying the finish.

END OF SECTION 09 58 13

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SECTION 09 64 70
WOOD DANCE FLOORING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wood dance flooring system.
 - 1. WoodSpring Sprung Floor System

1.2 RELATED SECTIONS

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

1.3 SUBMITTALS

- A. Submit under provisions of Section 01 30 00.
- B. Product Data: Manufacturer's data sheets on each finished product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Selection Samples: For each finish product specified, two complete sets of color samples representing manufacturer's full range of available colors and patterns.
- D. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Installer shall have at least three years experience in installing similar dance floor systems and shall be approved by the manufacturer.
- B. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - 1. Finish areas designated by Architect.
 - 2. Do not proceed with remaining work until workmanship, color, and gloss are approved by Architect.
 - 3. Rebuild mock-up area as required to produce acceptable work.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.

1.6 PROJECT CONDITIONS

- A. The flooring system shall not be delivered and installed until all masonry, plastering, tile work and all overhead mechanical and electrical trades are completed and building is enclosed and weather tight.
- B. Permanent heat, light and ventilation shall be installed and operating during and after installation, maintaining a temperature range of 65 to 75 degrees F (18 to 24 degrees C) and a relative humidity range of 35 percent to 50 percent.
- C. 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.

1.7 WARRANTY

- A. Manufacturer warrants its sub floor construction materials to be free from manufacturing defects for a minimum of two years and its integrated vinyl surfaces to be free from manufacturing defects for five years.

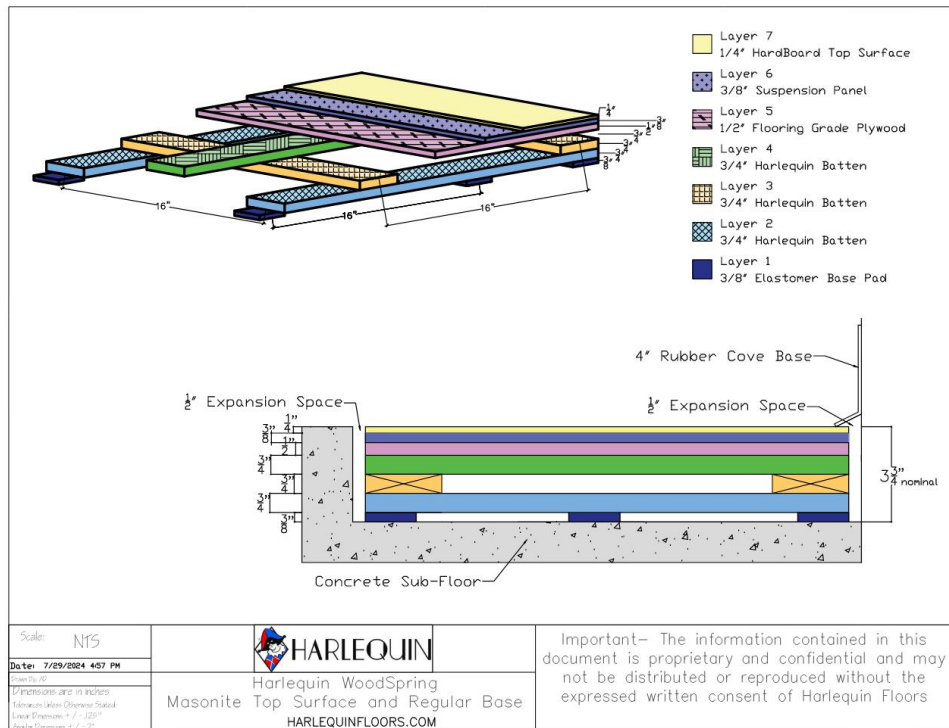
PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Harlequin Floors, which is located at: 1531 Glen Ave.; Moorestown, NJ 08057; Toll Free Tel: 800-642-6440; Fax: 856-231-4403; Email: request info (contact@harlequinfloors.com); Web: www.harlequinfloors.com, or comparable product of other manufacturers approved by the Architect.

2.2 HARLEQUIN WOODSPRING SPRUNG FLOOR SYSTEM – TYPE 1

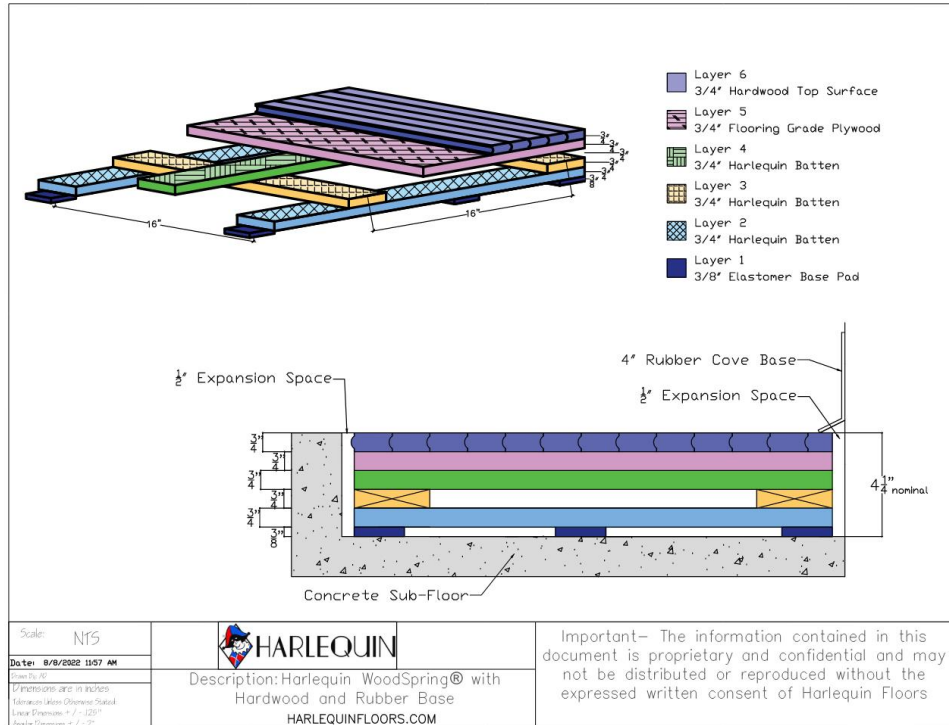
- A. System: A sprung or floating dance floor system consisting of a sub floor construction utilizing system specific components with an integrated surface.
 - 1. Product: Harlequin WoodSpring Sprung Floor System by American Harlequin Corporation.
 - 2. Surface: **6mm Masonite** on top of suspension pad over flooring grade plywood.
 - a. Finish: Painted Black.
- B. Performance:
 - 1. Uniform Distribution Load: Greater than 208 lb per sq ft (10 kN per sq m).
 - 2. Point Load: Greater than 809 lbs (3599 N).
 - 3. Rolling Load: greater than 337.2 lbs (1500 N).
 - 4. Average Shock Absorption: 64 percent.
 - 5. Vertical Deformation: 0.13 inches (3.3 mm).
 - 6. Area Deflection: 14.90 percent.
 - 7. Testing Standards: DIN 18032-2.
 - 8. Fire Rating: Bfls 1 to EN 13501.
 - 9. Weight with Hardwood Surface: 7 lbs per sq ft (0.335 kPa).
 - 10. Core Thickness: 3-1/8 inch (89 mm) nominal.
 - a. With Masonite: 3-3/4 inch (95 mm) nominal.
 - b. Overall Thickness: 3-3/4 inches.
- C. Performance Surface:
 - 1. Masonite Performance Surface: Painted Masonite Surface, Thickness: 0.25 inch (6 mm).
- D. Three layers of stringers.
- E. Progressive Resistance Suspension: Rubber suspension pads.
- F. Installation: Permanent.
- G. Floor Type: Sprung Floor Type 1



2.3 HARLEQUIN WOODSPRING SPRUNG FLOOR SYSTEM – TYPE 2

- A. System: A sprung or floating dance floor system consisting of a sub floor construction utilizing system specific components with an integrated surface.
 1. Product: Harlequin WoodSpring Sprung Floor System by American Harlequin Corporation.
 2. Surface: Hardwood.
- B. Performance:
 1. Uniform Distribution Load: Greater than 208 lb per sq ft (10 kN per sq m).
 2. Point Load: Greater than 809 lbs (3599 N).
 3. Rolling Load: greater than 337.2 lbs (1500 N).
 4. Average Shock Absorption: 64 percent.
 5. Vertical Deformation: 0.13 inches (3.3 mm).
 6. Area Deflection: 14.90 percent.
 7. Testing Standards: DIN 18032-2.
 8. Fire Rating: Bfls 1 to EN 13501.
 9. Weight with Hardwood Surface: 7 lbs per sq ft (0.335 kPa).
 10. Core Thickness: 3-1/2 inch (89 mm) nominal.
 - a. With Hardwood: 4-1/4 inch (108 mm) nominal.
 - b. Overall Thickness: 4-1/4 inches
- C. Performance Surface:
 1. **Hardwood Performance** Surface: Prefinished Hardwood Surface, Thickness: 0.75 inch (19 mm).
- D. Three layers of stringers.

- E. Progressive Resistance Suspension: Rubber suspension pads.
- F. Installation: Permanent.
- G. Floor Type: Sprung Floor Type 2



PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
 - 1. The Contractor shall provide a concrete slab smooth and level to a tolerance of 1/8 inch (3.2 mm) in a 10 ft (3 m) radius. High areas shall be ground down and low areas filled with appropriate leveling compounds.
 - 2. Concrete sub floors shall be cured and dry to industry standards. They shall have an adequate moisture barrier beneath and at the perimeter of the slab.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
 - 1. Flooring shall be stored on the premises for 24 to 48 hours before installation commences, or as required for acclimation. The flooring installer will make final determination of acclimation period.

3.4 PROTECTION

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

END OF SECTION 09 64 70

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**SECTION 09 65 00
RESILIENT FLOORING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Resilient tile flooring.
- B. Resilient base.
- C. Resilient stair accessories.
- D. Installation accessories (transition strips).

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

- A. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2022.
- B. ASTM F1344 - Standard Specification for Rubber Floor Tile; 2021a.
- C. ASTM F1861 - Standard Specification for Resilient Wall Base; 2021.
- D. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2023.
- E. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.
- F. RFCI (RWP) - Recommended Work Practices for Removal of Resilient Floor Coverings; 2018.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Shop Drawings: Indicate seaming plans and floor patterns.
- D. Verification Samples: Submit two samples, 6 by 6 inch in size illustrating color and pattern for each resilient flooring product specified.
- E. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.
- F. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of subfloor is acceptable.
- G. Manufacturer's Qualification Statement.
- H. Installer's Qualification Statement.
- I. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.
- J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Flooring Material: 100 square feet of each type and color.
 - 3. Extra Wall Base: not less than 10 linear feet for every 500 linear feet or of each type and color.
 - 4. Extra Stair Materials: Quantity equivalent to 5 percent of each type and color.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum three years documented experience.

- B. Installer Qualifications: Company specializing in installing specified flooring with minimum three years documented experience.
- C. Testing Agency Qualifications: Independent firm specializing in performing concrete slab moisture testing and inspections of the type specified in this section.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 TILE FLOORING

- A. Rubber Tile: Homogeneous rubber compound with a random scattered design.
 - 1. Manufacturers:
 - a. Basis-of-Design Product: Provide Nora as manufactured by Interface, or comparable product of other manufacturers approved by the Architect.
 - 2. Minimum Requirements: Comply with ASTM F1344, of Class corresponding to type specified.
 - 3. Product Name: Norament Kivo.
 - 4. Size: 39.53 by 39.53 inch nominal.
 - 5. Total Thickness: 2.7 mm.
 - 6. Color: 5661 Pumice
 - 7. Installation Pattern:

2.2 STAIR COVERING (ALTERNATE 2.5)

- A. Stair Treads: Rubber; full width and depth of stair tread in one piece.
 - 1. Manufacturers:
 - a. Basis-of-Design Product: Provide Nora as manufactured by Interface, or comparable product of other manufacturers approved by the Architect.
 - 2. Product Name: Norament Kivo.
 - 3. Color: 5661 Pumice
 - 4. Nominal Thickness: 2.7 mm.
- B. Stair Risers: Full height and width of tread in one piece, matching treads in material and color.
- C. Stair Stringers: Full height in one piece and in maximum available lengths, matching treads in material and color.
- D. Stair Nosings: 2 inch horizontal return, 1.77 inch vertical return, full width of stair tread in one piece.
 - 1. Product Name: Nora stair nosing T 5049 A/C, Article 805, for flooring 0.8 inches (2mm) to .11 inches (2.7mm)

2. Material: Rubber.
3. Nominal Thickness: 0.25 inch.
4. Texture: Smooth.
5. Color: To match stair treads.

2.3 RESILIENT BASE

- A. Basis-of-Design Product: Provide Johnsonite as manufactured by a Tarkett Company, or comparable product of other manufacturers approved by the Architect.
- B. Resilient Base: ASTM F1861, Type TS, rubber, vulcanized thermoset; style as scheduled.
 1. Product: Johnsonite Traditional Vinyl 1/8' (Type TV)
 2. Height: 4 inches.
 3. Thickness: 0.125 inch.
 4. Finish: Satin.
 5. Length: Coils in manufacturer's standard length. Joints to occur at inside corners where possible and in no case closer than 24 inches to an external corner.
 6. Outside Corners: Field fabricated.
 7. Inside Corners: Field fabricated.
 8. Colors and Patterns: See Drawings for locations.
 - a. Type B1 - 55 Silver Grey.
 - b. Type B2 - 63 Burnt Umber.
 - c. Type B3 - 20 Charcoal WG.
 9. Accessories: Premolded external corners and internal corners.

2.4 ACCESSORIES

- A. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.
- B. Moldings, Transition and Edge Strips: Same material as flooring.
 1. Profile and Dimensions: Provide a smooth transition between carpet and concrete (subfloor).
 2. Locations: Provide rubber molding accessories in areas indicated on Drawings.
 3. Colors and Patterns: Selected by Architect from manufacturers full range.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
- C. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
 1. Test as Follows:
 - a. Alkalinity (pH): ASTM F710.
 - b. Internal Relative Humidity: ASTM F2170.
 - c. Moisture Vapor Emission: ASTM F1869.

2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

3.2 PREPARATION

- A. Remove existing resilient flooring and flooring adhesives; follow the recommendations of RFCI (RWP).
- B. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- C. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor filler to achieve smooth, flat, hard surface.
- D. Prohibit traffic until filler is fully cured.
- E. Clean substrate.
- F. Apply primer as required to prevent "bleed-through" or interference with adhesion by substances that cannot be removed.

3.3 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install in accordance with manufacturer's written instructions.
- C. Adhesive-Applied Installation:
 1. Fit joints and butt seams tightly.
 2. Set flooring in place, press with heavy roller to attain full adhesion.
- D. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.4 INSTALLATION - TILE FLOORING

- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.
- B. Lay flooring with joints and seams parallel to building lines to produce symmetrical pattern.

3.5 INSTALLATION - RESILIENT BASE

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

3.6 INSTALLATION - STAIR COVERINGS

- A. Install stair coverings in one piece for full width and depth of tread.
- B. Install stringers configured tightly to stair profile.
- C. Adhere over entire surface. Fit accurately and securely.

3.7 CLEANING

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

3.8 PROTECTION

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

END OF SECTION 09 65 00

SECTION 09 66 23
RESINOUS MATRIX TERRAZZO FLOORING

PART 1 GENERAL

1.1 SECTION INCLUDE

- A. Thin-set, epoxy-resin terrazzo flooring.
- B. Precast epoxy-resin terrazzo units.
- C. Metal stops and divider strips for transitions between terrazzo and other flooring materials.
- D. Substrate-Crack-Suppression Membrane.

1.2 RELATED REQUIREMENTS

- A. Section 07 92 00 "Joint Sealants" for sealants installed with terrazzo.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to terrazzo including, but not limited to, the following:
 - a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
 - b. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - c. Review special terrazzo designs and patterns.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include terrazzo installation requirements. Include plans, sections, component details, and relationship to other work. Show layout of the following:
 - 1. Divider strips (Stops and 'L' Dividers for transitions between floor finishes).
 - 2. Control-joint strips.
 - 3. Accessory strips.
 - 4. Terrazzo patterns.
- C. Samples: For each exposed product and for each color and texture specified, 6 inches in size.
- D. Samples for Initial Selection: NTMA's "Terrazzo Color Palette" showing the full range of colors and patterns available for each terrazzo type.
- E. Samples for Verification: For each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected. Label each terrazzo Sample to identify manufacturer's matrix color and aggregate types, sizes, and proportions. Prepare Samples of same thickness and from same material to be used for the Work, in sizes indicated below:
 - 1. Terrazzo: Three (3) samples, minimum 6-inch square Samples.
 - 2. Accessories: 6-inch- long Samples of each exposed strip item required.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Material Certificates: For each type of terrazzo material or product.
- C. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.
- D. Preinstallation moisture-testing reports.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For terrazzo to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Engage an installer who is a contractor member of NTMA (National Terrazzo and Mosaic Association).
 - 2. Engage an installer who is certified in writing by terrazzo manufacturer as qualified to install manufacturer's products.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockups for terrazzo including accessories.
 - a. Size: Minimum 100 sq. ft. of typical poured-in-place flooring condition for each color and pattern in locations directed by Architect .
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number if any.
- B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting terrazzo installation.
- B. Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.
- C. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.
- D. Close spaces to traffic during terrazzo application and for not less than 24 hours after application unless manufacturer recommends a longer period.
- E. Control and collect water and dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.

1.10 REFERENCE STANDARDS

- A. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain primary terrazzo materials from single source from single manufacturer. Provide secondary materials including patching and fill material, joint sealant, and repair materials of type and from source recommended by manufacturer of primary materials.

- B. Source Limitations for Aggregates: Obtain each color, grade, type, and variety of granular materials from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

- A. NTMA Standards: Comply with NTMA's written recommendations for terrazzo type indicated unless more stringent requirements are specified.
- B. [Verify flooring products comply with](#) the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.3 THIN SET EPOXY-RESIN TERRAZZO

- A. Epoxy-Resin Terrazzo : Comply with manufacturer's written instructions for matrix and aggregate proportions and mixing.
 - 1. [Basis-of-Design Product](#): Subject to compliance with requirements, provide two color mixes manufactured by Concord Terrazzo Company, or comparable product by one of the following or a comparable product :
 - a. Terrazzo & Marble Supply Companies; Terroxy Resin Systems.
 - b. Master Terrazzo Technologies LLC; Morricite.
 - c. Key Resin Company; Key Epoxy Terrazzo.
- B. Mix Color and Pattern: Two are Required, to match Architect's sample.
 - 1. Type 1 in Criag Hall:
 - a. Series: Semi-Exotic - SE103.
 - b. Matrix Color: EZPour 158 – White
 - c. Aggregates: Marble Chips, Mother of Pearl.
 - 2. Type 2 in Art Annex:
 - a. Series: Pebble PEB-03.
 - b. Matrix Color: EZPour 158 – White
 - c. Aggregates: Pebbles, Porcelain, Marble
- C. Thickness: 3/8 inch.
- D. Integral base: See type B5 on drawings for locations.
 - 1. Height: 4 inches tall unless otherwise noted.
- E. Materials:
 - 1. Moisture Mitigation System: mitigate moisture vapor transmission through concrete slabs having greater than 75% relative humidity when tested according to ASTM F2170.
 - a. Basis of Design - Moisture Mitigation System 950G as manufactured by Terrazzco Concord Terrazzo Company, or equal.
 - 2. Substrate-Crack-Suppression Membrane: Product of terrazzo-resin manufacturer, having minimum 120 percent elongation potential according to ASTM D 412.
 - a. Basis of Design – Terrazzco Floor Aid Flexible Membrane 528G as manufactured by Terrazzco Concord Terrazzo Company, or equal.
 - 3. Primer: Manufacturer's product recommended for substrate and use indicated.
 - 4. Epoxy-Resin Matrix: Manufacturer's standard recommended for use indicated and in color required for mix indicated.
 - a. Physical Properties without Aggregates:

- 1) Hardness: 60 to 85 per ASTM D 2240, Shore D.
- 2) Minimum Tensile Strength: 3000 psi per ASTM D 638 for a 2-inch specimen made using a "C" die per ASTM D 412.
- 3) Minimum Compressive Strength: 10,000 psi per ASTM D 695, Specimen B cylinder.
- 4) Chemical Resistance: No deleterious effects by contaminants listed below after seven-day immersion at room temperature per ASTM D 1308.
 - (a) Distilled water.
 - (b) Mineral water.
 - (c) Isopropanol.
 - (d) Ethanol.
 - (e) percent detergent solution.
 - (f) percent soap solution.
 - (g) 5 percent acetic acid.
 - (h) 10 percent sodium hydroxide.
 - (i) 10 percent hydrochloric acid.
 - (j) 30 percent sulfuric acid.
- b. Physical Properties with Aggregates: For terrazzo blended according to manufacturer's recommendations with one part epoxy resin with three parts marble aggregate consisting of 60 percent No. 1 chips and 40 percent No. 0 chips that is ground and grouted to a 1/4-inch nominal thickness, and cured for 7 days at 75 deg F plus or minus 2 deg F and at 50 percent plus or minus 2 percent relative humidity.
 - 1) Flammability: Self-extinguishing, maximum extent of burning 1/4 inch according to ASTM D 635.
 - 2) Thermal Coefficient of Linear Expansion: 0.0025 inch/inch per deg F according to ASTM C 531.
5. Aggregates: Comply with NTMA gradation standards for mix indicated and contain no deleterious or foreign matter.
 - a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C 131/C 131M.
 - b. 24-Hour Absorption Rate: Less than 0.75 percent.
 - c. Dust Content: Less than 1.0 percent by weight.
6. Finishing Grout: Resin based.

2.4 PRECAST TERRAZZO TREADS

- A. Precast Terrazzo Stair Treads: Epoxy terrazzo units cast in maximum lengths possible. Comply with manufacturer's written instructions for fabricating precast terrazzo units in sizes and profiles indicated.
 1. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Concord Terrazzo Company
 2. Epoxy Resin Matrix: Manufacturer's standard recommended for use indicated.
 3. Aggregates: Comply with NTMA gradation standards for mix indicated, and containing no deleterious or foreign matter.
 - a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C131/C131M.
 - b. 24-Hour Absorption Rate: Less than 0.75 percent.
 - c. Dust Content: Less than 1.0 percent by weight.

4. Reinforcement: ASTM A615/A615M, Grade 60 bars, as required by unit size, profile, and thickness.
5. Abrasive Inserts: 1/2-inch- wide, silicon carbon/epoxy mixture in a charcoal grey – no black.
 - a. Provide two inserts, 1/2 inch apart, with first insert located 1 inch from nosing at adjacent stair riser locations, 4 inches less than stair width.
6. Color and Mix: To match Type 2 Thin Set Epoxy-Resin.
7. Finish: Honed.
8. Surface Sealer: Colorless, slip- and stain-resistant, penetrating sealer that is chemically neutral with pH factor between 7 and 8; does not affect color or physical properties of terrazzo type indicated; is recommend by sealer manufacturer for use with specified terrazzo; and complies with NTMA guide specification for terrazzo type applicable for this

2.5 STRIP MATERIALS

- A. Thin-Set Divider Strips: L-type angle in depth required for topping thickness indicated.
 1. Material: White-zinc alloy or Aluminum and Brass.
 2. Top Width: 1/8 inch.
- B. Heavy-Top Divider Strips: L-type angle in depth required for topping thickness indicated.
 1. Bottom-Section Material: Matching top-section material.
 2. Top-Section Material: White-zinc alloy or Aluminum Brass. .
 3. Top-Section Width: 1/8 inch.
 4. Locations: Where carts with wheels travel across and heavy traffic loads.
- C. Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material and color of divider strips and in depth required for topping thickness indicated.
- D. Accessory Strips: Match divider-strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:
 1. Edge-bead strips for exposed edges of terrazzo.
 2. Metal stops or transitions between different flooring materials from terrazzo.

2.6 MISCELLANEOUS ACCESSORIES

- A. Strip Adhesive: Epoxy-resin adhesive recommended by adhesive manufacturer for this use.
 1. [Verify adhesives have a VOC](#) content of 70 g/L or less.
 2. [Verify adhesive complies with the](#) testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Anchoring Devices:
 1. Strips: Provide mechanical anchoring devices or adhesives for strip materials as recommended by manufacturer and as required for secure attachment to substrate.
 2. Precast Terrazzo: Provide mechanical anchoring devices as recommended by fabricator for proper anchorage and support of units for conditions of installation and support.
- C. Patching and Fill Material: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.
- D. Joint Compound: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.
- E. Resinous Matrix Terrazzo Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by sealer manufacturer for use on terrazzo type indicated.

- F. Sealer: Slip- and stain-resistant, penetrating-type sealer that is chemically neutral; does not affect terrazzo color or physical properties; and is recommended by sealer manufacturer .
 - 1. Surface Friction: Not less than 0.6 according to ASTM D 2047.
 - 2. Acid-Base Properties: With pH factor between 7 and 10.
 - 3. [Verify products comply with the](#) requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and areas, 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, including levelness tolerances, have been corrected.

3.2 PREPARATION

- A. Clean substrates of substances, including oil, grease, and curing compounds, that might impair terrazzo bond. Provide clean, dry, and neutral substrate for terrazzo application.
- B. Concrete Slabs:
 - 1. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with terrazzo.
 - a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
 - b. Repair damaged and deteriorated concrete according to terrazzo manufacturer's written instructions.
 - c. Use patching and fill material to fill holes and depressions in substrates according to terrazzo manufacturer's written instructions.
- C. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
- D. Preinstallation Moisture Testing:
 - 1. Testing Agency: Engage a qualified testing agency to perform tests.
 - 2. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. , and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Moisture-Vapor-Emission Test: Maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours when tested according to ASTM F 1869 using anhydrous calcium chloride.
 - b. Relative Humidity Test: Maximum 75 percent relative humidity measurement when tested according to ASTM F 2170 using in-situ probes.
 - 3. Proceed with terrazzo installation only after concrete substrates pass moisture testing or after installation of moisture-vapor-emission-control membrane on substrate areas that fail testing.
- E. Substrate-Crack-Suppression Membrane: Install to isolate and suppress substrate cracks according to manufacturer's written instructions.
 - 1. Prepare and prefill substrate cracks with membrane material.
 - 2. Install membrane to produce full substrate coverage in areas to receive terrazzo.

3. Reinforce membrane with fiberglass scrim.
- F. Protect other work from water and dust generated by grinding operations. Control water and dust to comply with environmental protection regulations.
 1. Erect and maintain temporary enclosures and other suitable methods to limit water damage and dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

3.3 EPOXY-RESIN TERRAZZO INSTALLATION

- A. Comply with NTMA's written recommendations for terrazzo and accessory installation.
- B. Strip Materials:
 1. Divider and Control-Joint Strips:
 - a. Locate divider strips in locations indicated .
 - b. Install control-joint strips in locations indicated .
 - c. Install control-joint strips with 1/4-inch or less gap between strips, and install sealant in gap.
 - d. Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.
 2. Accessory Strips: Install as required to provide a complete installation and in locations indicated .
- C. Apply primer to terrazzo substrates according to manufacturer's written instructions.
- D. Place, rough grind, grout, cure grout, fine grind, and finish terrazzo according to manufacturer's written instructions.
 1. Installed Thickness: 3/8 inch nominal.
 2. Terrazzo Finishing: Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.
 - a. Rough Grinding: Grind with 24-grit or finer stones or with comparable diamond abrasives. Follow initial grind with 60/80-grit stones or with comparable diamond abrasives.
 - b. Grouting: Before grouting, clean terrazzo with water, rinse, and allow to dry. Apply and cure epoxy grout.
 - c. Fine Grinding/Polishing: Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted. Grind with 80 -grit stones or with comparable diamond abrasives until grout is removed from surface.
 3. Installation Tolerance: Limit variation in terrazzo surface from level to 1/4 inch in 10 feet ; noncumulative.

3.4 PRECAST TERRAZZO INSTALLATION

- A. Install precast terrazzo units using method recommended in writing by NTMA and manufacturer unless otherwise indicated.
- B. Do not install units that are chipped, cracked, discolored, or improperly finished.
- C. Seal joints between units with joint compound matching precast terrazzo matrix joint sealant.

3.5 REPAIR

- A. Cut out and replace terrazzo areas that evidence lack of bond with substrate. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by Architect.

3.6 CLEANING AND PROTECTION

- A. Cleaning:

1. Remove grinding dust from installation and adjacent areas.
 2. Wash surfaces with cleaner according to NTMA's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow them to dry thoroughly.
- B. Sealing:
1. Seal surfaces according to NTMA's written recommendations.
 2. Apply sealer according to sealer manufacturer's written instructions.
- C. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Substantial Completion.

END OF SECTION 09 66 23

SECTION 09 68 13
TILE CARPETING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Modular, carpet tile, fully adhered.
- B. Modular, walk-off carpet tile, loose laid.
- C. Removal of existing carpet tile.

1.2 RELATED REQUIREMENTS

- A. Section 02 41 00 - Demolition: Demolition of existing carpet locations.
- B. Section 09 65 13 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.
- C. Section 09 66 23 Resilient Matrix Terrazzo Flooring for metal stops (transitions) between terrazzo flooring and carpet tile.

1.3 REFERENCE STANDARDS

- A. AATCC Test Method 134 - Test Method for Electrostatic Propensity of Carpets; 2019.
- B. CRI 104 - Standard for Installation of Commercial Carpet; 2015.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- C. Shop Drawings: For carpet tile installation, plans showing the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
 - 2. Carpet tile type, color, and dye lot.
 - 3. Type of subfloor.
 - 4. Type of installation.
 - 5. Pattern of installation.
 - 6. Pattern type, location, and direction.
 - 7. Pile direction.
 - 8. Type, color, and location of insets and borders.
 - 9. Type, color, and location of edge, transition, and other accessory strips.
 - 10. Transition details to other flooring materials.
- D. Samples: Submit one carpet tile illustrating color and pattern design for each carpet color selected.
 - 1. Size: Full-size sample.
- E. Installer's Qualification Statement.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.
 - a. Not less than six modular units per each color and pattern installed.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience and approved by carpet tile manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104, Section 5, "Storage and Handling."

1.7 FIELD CONDITIONS

- A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
- B. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- C. 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.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.
- E. Deliver all materials to the installation site in the manufacturer's original packaging and in good condition. Packaging to contain manufacturer's name and marks, identification number, shipping and handling instructions and related information.
- F. Contractor shall include all work required for Sub-floor preparation and required work to prepare the existing floor for installation of the product specified in this document. Sub-floor preparation shall meet all conditions as specified in J+J Flooring Group's Kinetex textile composite flooring installation instructions.
- G. All Kinetix materials, including adhesives, are to be delivered to the site of installation at a minimum of 48 hours prior to the start of installation and stored in a clean and dry room that measures above 65°F and below 95°F and measures between 10% and 65% relative humidity (RH). To maintain temperature and relative humidity, permanent heating and air conditioning systems (HVAC) must be in operation. Place pallets of textile composite flooring modules on a flat surface (do not double stack pallets). After work is completed, the ambient room temperature should remain at 65°F and relative humidity between 10% and 65% for 48 hours. These materials and related adhesives shall be protected from the direct flow of heat from heating fixtures and appliances such as hot-air registers, radiators, or other. Site conditions shall include those specified in the flooring manufacturer's installation instructions and shall also include sufficient heat, light and power required for effective and efficient working condition.
- H. For Kinetix flooring, once the temperature and relative humidity in area for installation have been stabilized, loose lay the modules within the installation area and allow them to precondition for 48 hours prior to installation. Module installation shall not commence until painting and finishing work is complete and ceiling and overhead work is tested, approved and completed. Traffic shall be closed during the installation of the textile composite flooring products. Verify concrete slabs are dry per the standards for bond and moisture tests listed in the manufacturer's installation instructions.

1.8 WARRANTY

- A. Special Warranty for Carpet Tiles: If the product fails to perform as warranted when installed according to the manufacturer's installation instruction and maintained according to manufacturer's maintenance instructions, the affected area will be repaired or replaced at the expense of the manufacturer. The manufacturer will provide standard published written performance warranties for the following:
 - 1. Lifetime product performance. Will not delaminate along seams or lose more than five (5%) percent by weight of fiber during its useful life.

2. Lifetime static propensity, meaning built-in protection below 3.0 kv as tested under AATCC Test Method 134.
3. Lifetime Stain Removal
4. Lifetime Colorfastness (Light and Crocking)

PART 2 PRODUCTS

2.1 MATERIALS

- A. Tile Carpeting, Type 1:
 1. Product: Kinetex Carbon Copy 1854, module manufactured by J&J Flooring Group.
 2. Tile Size: 24 by 24 inch, nominal.
 3. Color: Photocopy 3406.
 4. Primary Backing Material: Polyester Felt Cushion.
 5. Construction: Textile Composite.
 6. Dye Method: Solution Dyed.
 7. Fiber Type: Polyester - Applied Pattern.
 8. Face Weight: 12 oz./sy (407 grams/m2).
 9. Installation Method: Brick.
- B. Tile Carpeting, Type 2: Walk-off modular tile.
 1. Product: Waterhog Modular Tile, manufactured American Floor Mats.
 2. Tile Size: 18 x 18 inch, nominal.
 3. Color: Charcoal.
 4. Height: 7/16 inch nub height.
- C. Tile Carpeting(CH#65579):
 1. Product: [Kinetex Carbon Copy 1854, module] manufactured by [J&J Flooring Group].
 2. Tile Size: [24 by 24] inch, nominal.
 3. Color: Photocopy 3408.
 4. Primary Backing Material: Polyester Felt Cushion.
 5. Construction: Textile Composite.
 6. Dye Method: Solution Dyed.
 7. Fiber Type: Polyester - Applied Pattern.
 8. Face Weight: 12 oz./sy (407 grams/m2).
 9. Installation Method: Brick.

2.2 ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Kinetex® Adhesive: an aggressive, pressure-sensitive adhesive designed for the installation of Kinetex textile composite flooring modules is required.
- C. Kinetex PreFix®: a quick installation for all Kinetex textile composite flooring products. The release liner easily peels away to reveal a series of pre-applied adhesive strips that securely anchor the Kinetex module in place. PreFix Primer is required.

- D. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
- E. Provide protective transition strips 3/16-inch to other floor covering thickness. Provide transition/reducing strips tapered to meet abutting materials as required.
- F. Metal Edge / Transition Strips: Extruded aluminum with mill finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive carpet tile.
- C. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.
- D. Walk-off Carpet Tile: Field verify dimension of recessed concrete slab to receive modular walk-off carpet tile. Determine modular tile layout to fill entire recessed portion of concrete without reducing any tile to less than 30% of its original size. Order quantity of carpet tiles accordingly.

3.2 PREPARATION

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

3.3 INSTALLATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.
- B. Starting installation constitutes acceptance of subfloor conditions.
- C. Blend carpet from different cartons to ensure minimal variation in color match.
- D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
- E. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.
- F. Trim carpet tile neatly at walls and around interruptions.
- G. Complete installation of edge strips, concealing exposed edges.
- H. Do not allow heavy foot traffic on newly carpeted area for at least 6 hours.
- I. Install transition strips at carpet terminations and flooring material changes. Compensate for variations at the junction of carpet and other flooring material by beveling of transition strips, feathering floor or shimming edge or transition strip.
- J. Walk-off Carpet Tile:
 - 1. Measure recessed concrete slab size.
 - 2. Determine modular tile layout to fill entire recessed portion of concrete without reducing any tile to less than 30% of its original size.

3. Cut carpet tiles clean and loose lay them into recess.

3.4 CLEANING

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

END OF SECTION 09 68 13

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SECTION 09 72 19
FELT WALLCOVERING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Felt Acoustic wall covering.

1.2 RELATED SECTIONS

1.3 REFERENCE

- A. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Submit manufacturer's product data, including complete laboratory test results, representative details, and other information necessary to establish that product is appropriate for application.
- B. Submit shop drawings indicating full extent of felt fabric acoustical wall covering. Include elevations indicating extent of felt fabric acoustical wall covering and seaming pattern.
- C. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- D. Verification Samples: For each finish product specified, two samples, minimum size 4 inch x 6 inches square representing actual product, color, and patterns.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum 5 year experience in providing felt similar in size, scope, and complexity to the work of this project
- B. Installer Qualifications: Minimum of five (5) years experience in the installation of natural materials such as leather, cork, or felt similar in size, scope, and complexity to the work of this project.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - 1. If installer holds less than five (5) years experience with felt wall covering, construct a mockup at the project site of a typical wall with felt fabric acoustical wall covering. Mock-up shall be a minimum of 10 feet x 10 feet and will be reviewed for seam quality, color range, and workmanship. Mock-up shall contain a typical opening, reveals, and other special conditions.
 - 2. Obtain Architect's acceptance of the mock-up before starting remainder of work. Retain mock-up during construction as a standard for judging completed work. Do not alter mock-up after acceptance. Mock-up may be incorporated into the work upon approval by the Architect.

1.7 PRE-INSTALLATION CONFERENCE

- A. Approximately two weeks prior to scheduled commencement of installation and associated work, meet at project site to discuss conformance with requirements of specification and job site conditions. Representatives of the architect, general contractor, installer, and other parties who are involved in the scope of this installation shall attend the meeting. Review submittals, specific concerns related to site conditions, installation methods, and other work governing the quality of the installation.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect materials from excessive moisture in shipment, storage, and handling. Material shall be inspected upon arrival for flaws or defects. Felt fabric acoustical wall covering that is flawed shall be rejected. Do not store felt fabric acoustical wall covering in bolts in an upright position or beneath other materials. Felt material must acclimate in the space to be installed a minimum of 48 hours.

1.9 FIELD CONDITIONS

- A. Schedule installation of felt fabric acoustical wall covering as late as possible in sequence of construction schedule to reduce damage.
- B. Space shall be enclosed and weather tight, with temperature and humidity stable at values near those indicated for final occupancy

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Manufacturer: FilzFelt, 425 CrossPoint Parkway, Getzville, NY 14068. Tel 800.482.7777, 716.446.2380. Fax 716.446.2396. info@filzfelt.com, www.filzfelt.com.
- B. Substitutions: Equal products of other manufacturer's are acceptable upon strict compliance with the requirements of this Section and approval by the Architect.

2.2 FELT WALLCOVERING

- A. 3mm Wool Design Felt by FilzFelt, www.filzfelt.com/3mm-wool-design-felt
 - 1. Content: 100% merino or karakul wool.
 - 2. Thickness: 3 mm (1/8 in).
 - 3. Thickness Tolerance: ± 0.3 mm ($\pm 1/10$ in).
 - 4. Width: 180 cm (70 3/4 in).
 - 5. Width Tolerance: ± 4 cm (± 1 3/5 in).
 - 6. Weight: 840 g / m² (48 oz / lin yd).
 - 7. Average Bolt Length: 22–25 lin m (24–27 lin yd).
 - 8. Backing: None.
 - 9. Color: 2 Colors required.
 - a. Type 1 (WF18): 437 AUBERGINE
 - b. Type 2 (WF19) : 136 WEINROT
 - 10. Properties:
 - a. NRC (((ASTM C423))) : 0.10.
 - b. SAA (((ASTM C423))) : 0.10.
 - c. ASTM E 84: Class A.
 - d. CAL 117: Complies.
 - e. CAN/ULC S102-10: FS Rating 20, SD Classification 155.
 - f. EN 13501-1 (Euroclass): B-s1-d0 (flame treated), D-s1-d0 (untreated).
 - g. FAR 25.853(a): Pass (60 second vertical burn), Pass (12 second vertical burn).
 - h. Fire Protection Code for Interior Material (China): B1.
 - i. GB/T 5455: B1 (flame treated).
 - j. ISO 5660.1-2002: Group 3.

- k. NFPA 260: Class 1.
- l. NFPA 701: Pass (flame treated).
- m. Colorfastness to Light Class: 4–5 (40 hours).
- n. Colorfastness to Crocking: Class 3–4 (wet), Class 4–5 (dry).
- o. ASTM 4966 (Martindale Abrasion Tester Method): 5,000 Grade 4, 10,000 Grade 3.5, 20,000 Grade 3.5, 40,000 Grade 3.
- p. ASTM D 5034 (Grab Test): 243 lb (avg of warp), 214 lb (avg of weft).
- q. Environmental: Oeko-Tex Standard 100 Certified Product Class II (100% Wool Design Felt), Meets VOC test limits for the CDPH v1.2 method (100% Wool Design Felt).

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrate and spaces in which work is to be performed.
- B. Do not begin installation until:
 - 1. Space has been enclosed and is weather-tight.
 - 2. Wet work has been completed and is dry.
 - 3. Painting is completed and wall base and floor covering is installed.
 - 4. Adjacent work of other trades such as woodwork, ceilings, wall coverings, reveals, and other contiguous work has been completed.
- C. Drywall surfaces shall be taped, bedded, sanded, and primed. Penetrations shall be sealed against air and moisture leakage through wall.
- D. Do not proceed with installation until unsatisfactory conditions have been corrected. Beginning of installation indicates acceptance of existing substrate conditions.

3.2 SURFACE PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions

3.3 INSTALLATION

- A. Install felt fabric acoustical wall covering in strict accordance with manufacturer instruction and recommendations.
 - 1. Inspect for surface irregularities and plan the cutting and piece selection to ensure that the “best side” will be visible. Wool felt is a natural material and minor changes and slight inclusions of natural fiber on the surface are evidence of 100% natural origin of the material. Allow felt to acclimate to the installation environment. After the shipping crates have been opened, the felt should be laid out individually on the floor for at least 48 hours. Variations in temperature and humidity may affect the size.
 - 2. Prepare the substrate to provide a smooth and even surface Level 5. Finish surface and prime.
 - 3. Trim the felt as needed to provide plumb and straight edges.
 - 4. Using a foam roller, coat the substrate with suitable adhesive. Allow to cure per the adhesive manufacturer’s application instructions.
 - 5. Apply the felt to the surface and use a weighted roller to smooth the surface, working from one end to remove any air bubbles. Rolling the entire surface also ensures maximum bond of the adhesive.

3.4 CLEANING AND PROTECTION

- A. Clean exposed surfaces of felt fabric acoustical wall covering.
- B. Remove surplus materials, rubbish and debris, leaving area in a neat and clean condition.
- C. Cover felt fabric acoustical wall covering installation with new, clean vinyl sheeting.

END OF SECTION 09 72 19

SECTION 09 73 00
ACOUSTICAL WOOD WALL PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Acoustic Kerf T&G (Tongue & Groove) wood wall panel.
- B. Acoustic Grille wood wall panel.
- C. Acoustical Backer

1.2 RELATED SECTIONS

- A. Section 09 22 16 Non-Structural Metal Framing.

1.3 COORDINATION

- A. Coordinate layout and installation of wood components and attachment systems with other construction that penetrates walls and ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For wood wall panel.
- C. Include elevations, sections, and details, drawn to scale, showing the following:
 - 1. Wood wall patterns and joints.
 - 2. Method of attaching.
 - 3. Wall-mounted items including, but not limited to, light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
- D. Samples: For each exposed product and for each type, color, and finish specified, 12 inches long by 12 inches wide or full width in size.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Store materials flat and level, raised from the floor.
- C. Handle components and accessories in a manner that prevents damage.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install interior wall panels until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work behind walls is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Store and acclimatize wood products in the spaces where they will be installed for a minimum of 72 hours immediately before installation.

PART 2 PRODUCTS

2.1 ACOUSTIC KERF T&G (TONGUE & GROOVE) WOOD WALL PANEL

- A. Basis-of-Design Product: Subject to compliance with requirements, provide "Linea Acoustic Kerf T&G" manufactured by Linea Ceiling and Wall System, or a comparable product by one of the following:
 - 1. 9 Wood
 - 2. Rulon
 - 3. Armstrong
- B. Wood Wall Finish Type WF12:
 - 1. Type: LINEA Acoustic Kerf – T&G
 - 2. Species: White Oak, Rift Cut Veneer.
 - 3. Panel size: 12" Wide x 10' Long.
 - 4. Panel Depth: 3/4 inches.
 - 5. Kerf Spacing: 8mm
 - 6. Finish: Natural Clear.
 - 7. Backer: Black SoundTex® Acoustic Backer
 - 8. Fire Rating: Class A per ASTM E-84 (USA) and CAN/ULC S102 (Canada)
 - 9. Attachment: 1/4 Zee Clips per manufacturer's recommendations.
 - 10. Wood Panel Accessories: Wood panel manufacturer's accessories required to provide a complete installation of wall covering in accordance with manufacturer's written installation instructions.
 - 11. Wood Trim: As indicated on the Drawings; in wood species and finished to match rails; with trim connectors recommended in writing by manufacturers.

2.2 ACOUSTIC SLAT WOOD WALL PANEL.

- A. Basis-of-Design Product: Subject to compliance with requirements, provide "Linea Grille Panel with Linea PET" manufactured by Linea Ceiling and Wall System, or a comparable product by one of the following:
 - 1. 9 Wood
 - 2. Rulon
 - 3. Armstrong
- B. Wood Wall Finish Type WF07:
 - 1. Type: LINEA Grile with LINEA PET
 - 2. Species: White Oak, Rift Cut Veneer.
 - 3. Spacing, Blades / LF: 7 Blades per Linear Foot.
 - 4. Blade size actual: Veneer 3/4" Thickness x 1 1/2" Depth.
 - 5. Panel Width: 12"
 - 6. Panel Length: Max length 10' (custom length) and a variety of other lengths - see drawings.
 - 7. Finish: Natural Clear.
 - 8. Backer: 100% PET.
 - a. Thickness: 1/2 inch.
 - b. Length: To match panel length with a max length of 10' (custom length).
 - c. Color: Charcoal.
 - 9. Attachment: 1/4 Zee Clips per manufacturer's recommendations.

- C. Acoustical insulation: Infill Panels: Provide width and length to fill concealed surface of plank, holding back edge of insulation nine inches from the edge of wood panel. Surface-burning characteristics for flame-spread index shall be 5 or less and smoke-developed index shall be 50 or less, as determined by testing per ASTM E 84, and to comply with the following requirements:
 - 1. Basis of Design – "Calla Square Lay-in Panel" as manufactured by Armstrong Inc., or equal.
 - a. Mineral-Fiber Type and Thickness: Glass fiber.
 - b. Size: 24 x 72 x 1"
 - c. Color: Black
 - d. Sound Absorption: .85 NCR
 - e. Sound blocking: 35 CAC
 - f. ASTM E1264, Fire Class A, Type IV, Form 2.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which wood components attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect wall installation and anchorage, and with requirements for installation tolerances and other conditions affecting performance of wood components.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each area and establish layout of wood walls.
- B. Balance border widths at opposite edges of each wall.
- C. Avoid using less-than-half-width units.

3.3 INSTALLATION

- A. Install wood components and accessories in accordance with manufacturer's written instructions and to accommodate natural expansion and contraction of wood products resulting from fluctuations in humidity.
- B. Cut wood components for accurate fit at borders and at interruptions and penetrations by other work.
- C. Stiffen edges of cut wood components as required to eliminate variations in flatness.
- D. Treat field-cut edges of wood components in accordance with manufacturer's written recommendations; finish exposed field cuts to match factory finish.
- E. Install wood components in coordination with attachment system and moldings and trim.
- F. Install wood components in patterns indicated on Drawings.
- G. Install field-constructed access panels in locations indicated on Drawings.

3.4 CLEANING

- A. Clean exposed surfaces of walls, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace wood components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented units.

END OF SECTION 09 73 00

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SECTION 09 84 36.16
CEMENTITIOUS WOOD-FIBER PANELS (TECTUM)

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Sound-absorbing wood-fiber ceiling and wall panels.

1.2 RELATED REQUIREMENTS:

- A. Section 06 10 00 "Rough Carpentry" for wood furring systems.
- B. Section 09 29 00 "Gypsum Board" for Sound attenuation insulation.
- C. Section 09 90 00 "Paints, Stans, and Coating" for painting the sound-absorbing panels.

1.3 DEFINITIONS

- A. NRC: Noise Reduction Coefficient.
- B. SAA: Sound Absorption Average.

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include panel edge, core material, and mounting indicated.
- B. Shop Drawings: For unit assembly and installation.
 - 1. Include reflected ceiling plans, elevations, sections, and mounting devices and details.
 - 2. Include details at joints and corners; and details at ceiling intersections and intersections with walls.
Indicate panel edge profile and core materials.
- C. Samples for Verification: For the following:
 - 1. 12-inch- square Sample(s) indicating each edge profile, color, and finish.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Panel elevations and reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Attachment details to ceiling and walls.
 - 2. Structural members to which suspension devices will be attached.
 - 3. Items penetrating or covered by units including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Alarms.
 - e. Sprinklers.
 - 4. Show operation of hinged and sliding components covered by or adjacent to units.
- B. Sample Warranty: For manufacturer's special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of unit to include in maintenance manuals. Include manufacturer's written cleaning instructions.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with panel manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.
- B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.
- C. Handle acoustical panel units with care to avoid chipping edges or other damage.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Verify unit locations and actual dimensions of openings and penetrations by field measurements before fabrication, and indicate them on Shop Drawings.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace units and components that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Acoustical performance.
 - b. Material defects including panel breakage.
 - 2. Warranty Period: 30 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain ceiling units specified in this Section from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Units shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.

2.3 MATERIALS

- A. Panel Materials: Manufacturer's standard.

2.4 SOUND-ABSORBING CEILING UNITS

- A. Sound-Absorbing Panels: Manufacturer's standard panel construction consisting of poplar wood fibers bonded with inorganic hydraulic cement.
 - 1. Manufacturers: Subject to compliance with requirements, provide panels by one of the following:

- a. Tectum; an Armstrong World Industries brand.
 - b. Cardinal Acoustics, Inc.
 - c. StrandTec; an ASI Architectural brand.
2. Panel Shape: Flat.
3. Mounting: Type C-40
4. Core: Cementitious-wood-fiber panel.
5. Edge Profile: Long edge beveled, short edge beveled.
6. Corner Detail in Elevation: Square with continuous edge profile indicated.
7. Acoustical Performance: Sound absorption NRC of 0.85 in accordance with ASTM C423 for Type C-40 mounting in accordance with ASTM E795.
8. Nominal Overall Panel Thickness: 1 inch.
9. Panel Width (nominal): 4 foot.
10. Panel Height (nominal): 8 foot.
11. Color Finish: Painted white at the factory. Panels to be field painted at the job site, per finish plan.
12. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested in accordance with ASTM D3273, ASTM D3274, or ASTM G21 and evaluated in accordance with ASTM D3274 or ASTM G21.

2.5 ACCESSORIES

- A. Provide accessories as follows:
 1. Tectum Painted Self-Drilling Screws:
 - a. Material: Steel.
 - b. Length: 2-3/8 inches or as required of Tectum wall panel thickness.
 - c. Color: Painted white. Screws to be field painted at the job site.
 2. Tectum Touch-Up Paint:
 - a. Color: Provided by contractor based on field painting color choice

2.6 FABRICATION

- A. Standard Construction: Use manufacturer's standard construction unless otherwise indicated.
- B. Measure each area and establish layout of panels and joints of sizes indicated on Drawings within a given area.
- C. Dimensional Tolerances of Finished Units: Plus or minus 1/8 inch for the following:
 1. Thickness.
 2. Edge straightness.
 3. Overall length and width.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine acoustical units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Allow acoustical panel materials to acclimate to jobsite conditions for a minimum 24 hours prior to installation.

3.3 INSTALLATION

- A. Install units in locations indicated. Unless otherwise indicated, install units with edges in alignment with walls and other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
- B. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.
- C. Screw head to be countersunk 1/4" beyond panel surface.
- D. Securely affix wall panels to stud framing. Engage vertical kerfs on the edges of the wall panels with splines. Apply adhesive or use Velcro hook and loop fastening where necessary.
- E. 1/4" bevel all panel edge conditions unless noted otherwise. (Bevel on horizontal edges and cut panels will need to be field or shop cut to provide bevel.)

3.4 INSTALLATION TOLERANCES

- A. Variation from Alignment with Surfaces: Plus or minus 1/16 inch in 48 inches, noncumulative.

3.5 CLEANING

- A. Clean panels on completion of installation to remove dust and other foreign materials in accordance with manufacturer's written instructions.
- B. Remove and replace each damaged or uncleanable panel.

3.6 PROTECTION

- A. Protect installed work from damage due to subsequent construction activity, including temperature and humidity limitations and dust control, so that the work will be without damage and deterioration at the time of acceptance by the Owner.

END OF SECTION 09 84 36.16

SECTION 09 90 00
PAINTS, HIGH PERFORMANCE PAINTS, STAINS, AND COATINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Interior paint and coating commercial systems including surface preparation.
- B. Exterior high-performance paint and coatings systems including surface preparation.
- C. Exterior paint and coating systems including surface preparation.

1.2 RELATED SECTIONS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 04 20 00 - Unit Masonry: Concrete Masonry Units (CMU) and brick.
- C. Section 05 12 16 - Fabricated Fireproofed Steel Columns.
- D. Section 05 50 00 - Metal Fabrications.
- E. Section 06 20 00 - Finish Carpentry.
- F. Section 06 40 00 - Architectural Woodwork.
- G. Section 08 11 13.16 - Custom Hollow Metal Doors and Frames.
- H. Section 09 21 16.23 - Gypsum Board Shaft Wall Assemblies.
- I. Section 23 05 00 - Common Work Results for HVAC.
- J. Section 26 05 00 - Common Work Results for Electrical.

1.3 REFERENCES

- A. Steel Structures Painting Council (SSPC):
 - 1. SSPC-SP 1 - Solvent Cleaning.
 - 2. SSPC-SP 2 - Hand Tool Cleaning.
 - 3. SSPC-SP 3 - Power Tool Cleaning.
 - 4. SSPC-SP5/NACE No. 1, White Metal Blast Cleaning.
 - 5. SSPC-SP6/NACE No. 3, Commercial Blast Cleaning.
 - 6. SSPC-SP7/NACE No. 4, Brush-Off Blast Cleaning.
 - 7. SSPC-SP10/NACE No. 2, Near-White Blast Cleaning.
 - 8. SSPC-SP11, Power Tool Cleaning to Bare Metal.
 - 9. SSPC-SP12/NACE No. 5, Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating.
 - 10. SSPC-SP 13 / NACE No. 6 Surface Preparation for Concrete.
- B. Material Safety Data Sheets / Environmental Data Sheets: Per manufacturer's MSDS/EDS for specific VOCs (calculated per 40 CFR 59.406). VOCs may vary by base and sheen.
- C. California Department of Public Health (CDPH):
 - 1. CDPH v1.1-2010 and V1.2-2017

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: For each paint system indicated, including.
 - 1. Product characteristics.
 - 2. Surface preparation instructions and recommendations.

3. Primer requirements and finish specification.
4. Storage and handling requirements and recommendations.
5. Application methods.
6. Cautions for storage, handling and installation.
- C. Selection Samples: Submit a complete set of color chips that represent the full range of manufacturer's products, colors, and sheens available.
- D. Verification Samples: For each finished product specified, submit samples that represent the actual product, color, and sheen.
- E. Coating Maintenance Manual: Upon conclusion of project, the Contractor or paint manufacturer/supplier shall furnish a coating maintenance manual, such as Sherwin-Williams, "Custodian Project Color and Product Information" report or equal. Manual shall include an Area Summary with finish schedule, Area Detail designating where each product/color/finish was used, product data pages, Material Safety Data Sheets, care and cleaning instructions, touch-up procedures, and color samples of each color and finish used.
- F. Only submit complying products based on project requirements (i.e. LEED). One must also comply with the regulations regarding VOCs (CARB, OTC, SCAQMD, LADCO). To ensure compliance with district regulations and other rules, businesses that perform coating activities should contact the local district in each area where the coating will be used.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Paint exposed surfaces. If a color of finish, or a surface is not specifically mentioned, Architect will select from standard products, colors, and sheens available.
- C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels unless indicated.
- D. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 1. Finish surfaces for verification of products, colors, and sheens.
 2. Finish area designated by Architect.
 3. Provide samples that designate primer and finish coats.
 4. Compatibility and Adhesion: Check after one week of drying and curing by testing in accordance with ASTM D3359; Adhesion by tape test. If the coating system is incompatible, additional surface preparation up to and including complete removal may be required.
 5. Do not proceed with remaining work until the Architect approves the mock-up.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver manufacturer's unopened containers to the work site. Packaging shall bear the manufacturer's name, label, and the following list of information.
 1. Product name, and type (description).
 2. Application and use instructions.
 3. Surface preparation.
 4. VOC content.
 5. Environmental handling.

6. Batch date.
7. Color number.
- B. Storage: Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.
- C. Store materials in an area that is within the acceptable temperature range, per manufacturer's instructions. Protect from freezing.
- D. Handling: Maintain a clean, dry storage area, to prevent contamination or damage to the coatings.

1.7 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.

1.8 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied and, in the quantities, described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.
- B. Furnish Owner with an additional one percent of each material and color, but not less than 1 gal (3.8 l) or 1 case, as appropriate.

1.9 REFERENCE STANDARDS

- A. ASTM D3359 - Standard Test Methods for Rating Adhesion by Tape Test; 2023.
- B. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).
- C. SSPC-SP 2 - Hand Tool Cleaning; 2018.
- D. SSPC-SP 3 - Power Tool Cleaning; 2018.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Sherwin-Williams, which is located at: 101 Prospect Ave.; Cleveland, OH 44115; ASD Toll Free Tel: 800-524-5979; Tel: 216-566-2000; Fax: 440-826-1989; Email: request infospecifications@sherwin.com; Web: www.swspecs.com.
- B. Requests for substitutions will be considered in accordance with the provisions of Section 01 60 00 - Product Requirements.

2.2 APPLICATIONS/SCOPE

- A. Interior Paint and Coating Commercial Systems:
 1. Concrete: Poured, precast, tilt-up, cast-in-place, cement board, plaster.
 2. Masonry: Concrete masonry units, including split-face, scored, and smooth block.
 3. Metal: Aluminum, galvanized steel.
 4. Metal: Structural steel, joists, trusses, beams, partitions, and similar items.
 5. Wood: Walls, ceilings, doors, trim and similar items.
 6. Drywall: Drywall board, Gypsum board.
- B. High Performance Exterior Paint and Coating Systems:
 1. Metal: Miscellaneous iron, ornamental iron, ferrous metal.
- C. Exterior Paint and Coating Systems:

1. Metal: Miscellaneous iron, ornamental iron, ferrous metal.

2.3 PAINT MATERIALS - GENERAL

- A. Paints and Coatings:
 1. Unless otherwise indicated, provide factory-mixed coatings. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
 2. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color. Or follow manufacturer's product instructions for optimal color conformance.
- B. Primers: Where the manufacturer offers options on primers for a particular substrate, use a primer categorized as "best" by the manufacturer.
- C. Coating Application Accessories: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required, per manufacturer's specifications.
- D. Color: Refer to Finish Schedule for paint colors, and as selected.

2.4 INTERIOR PAINT AND COATING COMMERCIAL SYSTEMS

- A. Concrete: Walls and Ceilings, Poured Concrete, Precast Concrete, Unglazed Brick, Cement Board, Tilt-Up, Cast-In-Place including Plaster Walls and Ceilings.
 1. Latex Systems:
 - a. Eg-Shel / Satin Finish:
 - 1) 1st Coat: S-W Loxon Concrete and Masonry Primer Sealer, LX02W50 (8 mils. wet, 3.2 mils. dry per coat).
 - 2) 2nd Coat: S-W ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series.
 - 3) 3rd Coat: S-W ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series (4 mils. wet, 1.7 mils. dry per coat).
- B. Masonry CMU: Concrete, Split Face, Scored, Smooth, High Density, Low Density, and Fluted.
 1. Latex Systems:
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: S-W Pro Industrial Heavy Duty Block Filler, at 16.0 mils wet, 8.0 mils dry.
 - 2) 2nd Coat: S-W ProMar 200 Zero VOC Latex Semi-Gloss, B31-2600 Series.
 - 3) 3rd Coat: S-W ProMar 200 Zero VOC Latex Semi-Gloss, B31-2600 Series (4 mils. wet, 1.5 mils. dry per coat).
- C. Metal; Galvanized: Exposed Ceilings and Duct work.
 1. Dryfall Waterborne Topcoats:
 - a. Flat Finish:
 - 1) 1st Coat: S-W Pro Industrial Waterborne Acrylic Dryfall, B42-181 Series.
- D. Metal: Structural Steel Columns, Joists, Trusses, Beams, Miscellaneous and Ornamental Iron, Structural Iron, and Ferrous Metal.
 1. Latex Systems:
 - a. Semi-Gloss Finish High Performance:
 - 1) 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series (5.0 mils. wet, 2.0 mils. dry per coat).
 - 2) 2nd Coat: S-W Pro Industrial Acrylic Semi-Gloss, B66-650 Series.

- 3) 3rd Coat: S-W Pro Industrial Acrylic Semi-Gloss, B66-650 Series (2.0-4.0 mils. dry per coat).
 - (a) Alkyd Systems; Waterbased: Suggested for hand rails, stair stringers.
- b. Semi-Gloss Finish:
 - 1) 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series (5.0 mils. wet, 2.0 mils. dry per coat).
 - 2) 2nd Coat: S-W Pro Industrial Waterbased Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series.
 - 3) 3rd Coat: S-W Pro Industrial Waterbased Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series (4.0-5.0 mils. wet, 1.4 - 1.7 mils. dry per coat).
- E. Wood: Walls, ceilings, doors, and trim.
 - 1. Stain and Varnish System:
 - a. Satin Finish:
 - 1) 1st Coat: SW Minwax Performance Series Tintable Wood Stain 250 VOC (optional).
 - 2) 2nd Coat: S-W Minwax Waterbased Oil-Modified Polyurethane.
 - 3) 3rd Coat: S-W Minwax Waterbased Oil-Modified Polyurethane (4 mils. wet, 1.0 mil dry per coat).
- F. Drywall: Walls, Ceilings, Gypsum Board, and similar items.
 - 1. Latex Systems:
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: S-W ProMar200 Zero VOC Interior Latex Primer, B28W2600 (4 mils. wet, 1.5 mils. dry per coat).
 - 2) 2nd Coat: S-W ProMar 200 Zero VOC Latex Semi-Gloss, B31-2600 Series.
 - 3) 3rd Coat: S-W ProMar 200 Zero VOC Latex Semi-Gloss, B31-2600 Series (4 mils. wet, 1.5 mils. dry per coat).
 - b. Eg-Shel / Satin Finish:
 - 1) 1st Coat: S-W ProMar 200 Zero VOC Interior Latex Primer, B28W2600 (4 mils. wet, 1.5 mils. dry per coat).
 - 2) 2nd Coat: S-W ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series.
 - 3) 3rd Coat: S-W ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series (4 mils. wet, 1.7 mils. dry per coat).
 - c. Eg-Shel Finish Scuff Resistant Waterbase Enamel: Consider for added durability and burnish protection, hallways, stairwells, gym walls, ultradeep accent colors
 - 1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600 (4 mils. wet, 1.5 mils. dry per coat).
 - 2) 2nd Coat: Sherwin-Williams Scuff Tuff Int. Waterbased Enamel, Eg-Shel, S24-150 Series.
 - 3) 3rd Coat: Sherwin-Williams Scuff Tuff Int. Waterbased Enamel, Eg-Shel, S24-150 Series (4 mils. wet, 1.2 mils. dry per coat).
 - d. Flat Finish: Ceilings
 - 1) 1st Coat: S-W ProMar 200 Zero VOC Interior Latex Primer, B28W2600 (4 mils. wet, 1.5 mils. dry per coat).
 - 2) 2nd Coat: S-W ProMar 200 Zero VOC Latex Flat, B30-12600 Series.

- 3) 3rd Coat: S-W ProMar 200 Zero VOC Latex Flat, B30-12600 Series (4 mils. wet, 1.6 mils. dry per coat).
2. Epoxy Systems; Waterbased: Restrooms, Kitchens and Locker Rooms.
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: S-W ProMar 200 Zero VOC Interior Latex Primer, B28W2600 (4 mils. wet, 1.5 mils. dry per coat).
 - 2) 2nd Coat: S-W Pro Industrial Pre-Catalyzed Waterbased Epoxy, K46- Series.
 - 3) 3rd Coat: S-W Pro Industrial Pre-Catalyzed Waterbased Epoxy, K46- Series (4 mils. wet, 1.5 mils. dry per coat).

2.5 HIGH PERFORMANCE EXTERIOR PAINT AND COATING SYSTEMS

- A. Metal - (Structural Steel Columns, Joists, Trusses, Beams, Miscellaneous and Ornamental Iron, Structural Iron, Ferrous Metal).
 1. Urethane System; Solvent Base: Use if 2 part High Performance required.
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series (5.0-10.0 mils. wet, 1.8-3.6 mils. dry per coat).
 - 2) 2nd Coat: S-W Hi-Solids Polyurethane Semi-Gloss, B65-350 Series.
 - 3) 3rd Coat: S-W Hi-Solids Polyurethane Semi-Gloss, B65-350 Series. (4.5-8.0 mils. wet, 3.0-5.0 mils. dry per coat).

2.6 EXTERIOR PAINT AND COATING SYSTEMS

- A. Metal: Miscellaneous. Iron, Ornamental Iron, Structural Iron and Steel, Ferrous Metal.
 1. Latex Systems:
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series (5.0-10.0 mils. wet, 1.8-3.6 mils. dry per coat).
 - 2) 2nd Coat: S-W Pro Industrial Acrylic Semi-Gloss, B66-650.
 - 3) 3rd Coat: S-W Pro Industrial Acrylic Semi-Gloss, B66-650 (2.0-4.0 mils. dry per coat).

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until the substrates have been properly prepared; notify Architect of unsatisfactory conditions before proceeding. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- B. Proceed with work only after conditions have been corrected and approved by all parties, otherwise application of coatings will be considered as an acceptance of surface conditions.
- C. Previously Painted Surfaces: Verify that existing painted surfaces do not contain lead based paints, notify Architect immediately if lead based paints are encountered.

3.2 SURFACE PREPARATION

- A. General: Surfaces shall be dry and in sound condition. Remove oil, dust, dirt, loose rust, peeling paint, or other contamination to ensure good adhesion.

1. Prior to attempting to remove mildew, it is recommended to test any cleaner on a small, inconspicuous area prior to use. Bleach and bleaching type cleaners may damage or discolor existing paint films. Bleach alternative cleaning solutions are advised.
 2. Remove mildew before painting by washing with a solution of 1 part liquid household bleach and 3 parts of warm water. Apply solution and scrub the mildewed area. Allow solution to remain on the surface for 10 minutes. Rinse thoroughly with clean water and allow the surface to dry before painting. Wear protective glasses or goggles, waterproof gloves, and protective clothing. Quickly wash off any of the mixture that comes in contact with your skin. Do not add detergents or ammonia to the bleach/water solution.
 3. Remove items including but not limited to thermostats, electrical outlets, switch covers and similar items prior to painting. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
 4. No exterior painting should be done immediately after a rain, during foggy weather, when rain is predicted, or when the temperature is below 50 degrees F (10 degrees C), unless products are designed specifically for these conditions. On large expanses of metal siding, the air, surface, and material temperatures must be 50 degrees F (10 degrees F) or higher to use low temperature products.
- B. Aluminum: Remove all oil, grease, dirt, oxide, and other foreign material by cleaning per SSPC-SP1, Solvent Cleaning.
- C. Block (Cinder and Concrete): Remove all loose mortar and foreign material. Surface must be free of laitance, concrete dust, dirt, form release agents, moisture curing membranes, loose cement, and hardeners. Concrete and mortar must be cured at least 30 days at 75 degrees F (24 degrees C). The pH of the surface should be between 6 and 9 unless the products are designed to be used in high pH environments. On tilt-up and poured-in-place concrete, commercial detergents and abrasive blasting may be necessary to prepare the surface. Fill bug holes, air pockets, and other voids with a cement patching compound.
- D. Concrete, SSPC-SP13 or NACE 6: This standard gives requirements for surface preparation of concrete by mechanical, chemical, or thermal methods prior to the application of bonded protective coating or lining systems. The requirements of this standard are applicable to all types of cementitious surfaces including cast-in-place concrete floors and walls, precast slabs, masonry walls, and shotcrete surfaces. An acceptable prepared concrete surface should be free of contaminants, laitance, loosely adhering concrete, and dust, and should provide a sound, uniform substrate suitable for the application of protective coating or lining systems.
- E. Cement Composition Siding/Panels: Remove all surface contamination by washing with an appropriate cleaner, rinse thoroughly and allow to dry. Existing peeled or checked paint should be scraped and sanded to a sound surface. Pressure clean, if needed, with a minimum of 2100 psi pressure to remove all dirt, dust, grease, oil, loose particles, laitance, foreign material, and peeling or defective coatings. Allow the surface to dry thoroughly. The pH of the surface should be between 6 and 9 unless the products are designed to be used in high pH environments.
- F. Copper and Stainless Steel: Remove all oil, grease, dirt, oxide, and other foreign material by cleaning per SSPC-SP 2, Hand Tool Cleaning.
- G. Exterior Composition Board (Hardboard): Some composition boards may exude a waxy material that must be removed with a solvent prior to coating. Whether factory primed or unprimed, exterior composition board siding (hardboard) must be cleaned thoroughly and primed with an alkyl primer.

- H. Drywall - Exterior: Must be clean and dry. All nail heads must be set and spackled. Joints must be taped and covered with a joint compound. Spackled nail heads and tape joints must be sanded smooth, and all dust removed prior to painting. Exterior surfaces must be spackled with exterior grade compounds.
- I. Drywall - Interior: Must be clean and dry. All nail heads must be set and spackled. Joints must be taped and covered with a joint compound. Spackled nail heads and tape joints must be sanded smooth, and all dust removed prior to painting.
- J. Galvanized Metal: Clean per SSPC-SP1 using detergent and water or a degreasing cleaner to remove greases and oils. Apply to a test area, priming as required. Allow the coating to dry at least one week before testing. If adhesion is poor, Brush Blast per SSPC-SP16 is necessary to remove these treatments.
- K. Plaster: Must be allowed to dry thoroughly for at least 30 days before painting unless the products are designed to be used in high pH environments. Room must be ventilated while drying; in cold, damp weather, rooms must be heated. Damaged areas must be repaired with appropriate patching material. Bare plaster must be cured and hard. Textured, soft, porous, or powdery plaster should be treated with a solution of 1 pint household vinegar to 1 gallon of water. Repeat until the surface is hard, rinse with clear water and allow to dry.
- L. Steel: Structural, Plate, And Similar Items: Should be cleaned by one or more of the surface preparations described below. These methods are used throughout the world for describing methods for cleaning structural steel. Visual standards are available through the Society of Protective Coatings. A brief description of these standards together with numbers by which they can be specified follow.
 - 1. Solvent Cleaning, SSPC-SP1: Solvent cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants. Solvent cleaning does not remove rust or mill scale. Change rags and cleaning solution frequently so that deposits of oil and grease are not spread over additional areas in the cleaning process. Be sure to allow adequate ventilation.
 - 2. Hand Tool Cleaning, SSPC-SP2: Hand Tool Cleaning removes all loose mill scale, loose rust, and other detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Beforehand tool cleaning, remove visible oil, grease, soluble welding residues, and salts by the methods outlined in SSPC-SP1.
 - 3. Power Tool Cleaning, SSPC-SP3: Power Tool Cleaning removes all loose mill scale, loose rust, and other detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Before power tool cleaning, remove visible oil, grease, soluble welding residues, and salts by the methods outlined in SSPC-SP1.
 - 4. White Metal Blast Cleaning, SSPC-SP5 or NACE 1: A White Metal Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.
 - 5. Commercial Blast Cleaning, SSPC-SP6 or NACE 3: A Commercial Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except for staining. Staining shall be limited to no more than 33 percent of each square inch of surface area and may consist of light shadows, slight streaks, or minor discoloration caused by stains of rust, stains of mill scale, or stains of previously applied paint. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.

6. Brush-Off Blast Cleaning, SSPC-SP7 or NACE 4: A Brush-Off Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, loose mill scale, loose rust, and loose paint. Tightly adherent mill scale, rust, and paint may remain on the surface. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP 1 or other agreed upon methods.
7. Power Tool Cleaning to Bare Metal, SSPC-SP11: Metallic surfaces that are prepared according to this specification, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxide corrosion products, and other foreign matter. Slight residues of rust and paint may be left in the lower portions of pits if the original surface is pitted. Prior to power tool surface preparation, remove visible deposits of oil or grease by any of the methods specified in SSPC-SP1, Solvent Cleaning, or other agreed upon methods.
8. Near-White Blast Cleaning, SSPC-SP10 or NACE 2: A Near White Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except for staining. Staining shall be limited to no more than 5 percent of each square inch of surface area and may consist of light shadows, slight streaks, or minor discoloration caused by stains of rust, stains of mill scale, or stains of previously applied paint. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.
9. High- and Ultra-High Pressure Water Jetting for Steel and Other Hard Materials: SSPC-SP12 or NACE 5: This standard provides requirements for the use of high- and ultra-high pressure water jetting to achieve various degrees of surface cleanliness. This standard is limited in scope to the use of water only without the addition of solid particles in the stream.
10. Water Blasting, SSPC-SP12/NACE No. 5: Removal of oil grease dirt, loose rust, loose mill scale, and loose paint by water at pressures of 2,000 to 2,500 psi at a flow of 4 to 14 gallons per minute.
- M. Vinyl Siding, Architectural Plastics, EIFS and Fiberglass: Clean vinyl siding thoroughly by scrubbing with a warm, soapy water solution. Rinse thoroughly. Do not paint vinyl siding with any color darker than the original color unless the paint system features Sherwin-Williams VinylSafe technology. Painting with darker colors that are not Sherwin-Williams VinylSafe may cause siding to warp. Follow all painting guidelines of the vinyl manufacturer when painting. Only paint properly installed vinyl siding. Deviating from the manufacturer's painting guidelines may cause the warranty to be voided.
- N. Stucco: Must be clean and free of any loose stucco. If recommended procedures for applying stucco are followed, and normal drying conditions prevail, the surface may be painted in 30 days. The pH of the surface should be between 6 and 9 unless the products are designed to be used in high pH environments such as Loxon.
- O. Wood: Must be clean and dry. Prime and paint as soon as possible. Knots and pitch streaks must be scraped, sanded, and spot primed before a full priming coat is applied. Patch all nail holes and imperfections with a wood filler or putty and sand smooth.

3.3 INSTALLATION

- A. Apply all coatings and materials with the manufacturer's specifications in mind. Mix and thin coatings according to manufacturer's recommendations.
- B. Do not apply it to wet or damp surfaces. Wait at least 30 days before applying to new concrete or masonry. Or follow manufacturer's procedures to apply appropriate coatings prior to 30 days. Test new concrete for moisture content. Wait until wood is fully dry after rain or morning fog or dew.
- C. Apply coatings using methods recommended by manufacturer.

- D. Uniformly apply coatings without runs, drips, or sags, without brush marks, and with consistent sheen.
- E. Apply coatings at spreading rate required to achieve the manufacturers recommended dry film thickness.
- F. Regardless of the number of coats specified, apply as many coats as necessary for complete hide, and uniform appearance.
- G. Inspection: The coated surface must be inspected and approved by the Architect just prior to the application of each coat.

3.4 PROTECTION

- A. Protect finished coatings from damage until completion of project.
- B. Touch-up damaged coatings after substantial completion, following manufacturer's recommendation for touch up or repair of damaged coatings. Repair any defects that will hinder the performance of the coatings.

END OF SECTION 09 90 00

SECTION 09 96 72
FLUID APPLIED INSULATION COATING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Section includes a spray-applied insulative coating including primer and insulative coating for the following applications:
 - 1. Applied to steel penetrating the exterior envelope without a physical thermal break, from 24 inches outboard of the face of the wall to 24 inches inside the face of metal framing.

1.2 RELATED SECTIONS

- A. Section 05 12 00 - Structural Steel Framing: for structural steel to receive fluid-applied insulation coating, and coordination of steel primers with insulation coating.
- B. Section 05 40 00 - Cold-Former Metal Framing: for structural steel to receive fluid-applied insulation coating, and coordination of steel primers with insulation coating.
- C. Section 07 21 00 - Thermal Insulation: for building insulation.
- D. Section 09 90 00 - Paints, Stains, and Coatings: for painting of exposed exterior steel.

1.3 REFERENCE STANDARDS

- A. American Institute of Steel Construction (AISC)
 - 1. AISC 303-05 Section 10 – Erection and storage of coated material during shipment and site handling shall be protected to minimize field touch up.
- B. American Society of Testing and Materials (ASTM)
 - 1. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus
 - 2. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - 3. ASTM C1057 – Standard Practice for Determination of Skin Contact Temperature from Heated Surfaces Using a Mathematical Model and Thermesthesiometer.
 - 4. ASTM D870 – Standard Practice for Testing Water Resistance of Coatings Using Water Immersion.
 - 5. ASTM D4060 – Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
 - 6. ASTM D4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
 - 7. ASTM D4585 – Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation.
 - 8. ASTM D4587 – Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings.
 - 9. ASTM D4624/ISO 4624 – Standard Test Method for Bond Strength
 - 10. ASTM D5894 – Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet).
 - 11. ASTM D638 – Standard Test Method for Tensile Strength
 - 12. ASTM D695 – Standard Test Method for Compressive Strength
 - 13. ASTM D790 – Standard Test Method for Flexural Strength
 - 14. ASTM D2240 – Standard Test Method for Determining Durometer Hardness

15. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
16. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
- C. Association of the American Walls and Ceilings Industries (AWCI)
- D. Underwriters Laboratory (UL):
 1. UL 263: Standard for Fire Tests of Building Construction and Materials.
- E. The Society of Protective Coatings (SSPC)
 1. SSPC-SP6: Commercial Blast Cleaning Standard
 2. SSPC-PA1: Shop, Field, and Maintenance Painting of Steel.
 3. SSPC-PA2: Procedure for Determining Conformance to Dry Coating Thickness Requirements.

1.4 SYSTEM DESCRIPTION

- A. The liquid applied thermal break acrylic material shall be applied at the required thickness specified by the manufacturer in order to mitigate thermal bridging. In no case shall the K-value of the liquid applied thermal break be more than 0.040 W/mK.

1.5 SUSTAINABLE DESIGN REQUIREMENTS

- A. Materials, products and procedures within this Section shall contribute to the Project's sustainable design goals, including those defined by the USGBC's LEED Version 4 and/or Version 4.1 for Building Design and Construction Rating System. Refer to Section 01 81 13.14 (Sustainable Design Requirements) for the project's target certification level and specific certification requirements. The Contractor shall ensure that the requirements related to the project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work related to this section proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification target.

1.6 SUBMITTALS

- A. Product Data: Submit product data including manufacturers technical data indicating product performance characteristics, performance and limitation criteria.
- B. Installation Details: Submit installation details prepared by the manufacturer all locations to receive fluid-applied insulation coatings.
- C. Manufacturer's Instructions: Submit manufacturer written installation instructions.
- D. Applicator Qualifications: Submit applicators current certification as a manufacturer trained applicator.
- E. LEED Submittals: Submit product and material documentation to comply with and contribute to the Project's LEED requirements, as specified in Section 01 81 13.14 (Sustainable Design Requirements).

1.7 QUALITY ASSURANCE

- A. Manufacturer:
 1. Company specializing in manufacturing product in this section with a minimum of 2 years documented experience in manufacturing insulative technology.
 2. Applicator: Company specializing in applying the work of this section with documented experience and trained by the manufacturer.
 3. Fluid Applied Thermal Break Acrylic system shall be the complete system from a sole source consisting of primer, acrylic thermal break material and topcoat. All materials shall be LEED 2009 compliant.
- B. Mock-up:

1. Minimum thirty days prior to application in any area, provide mock-up Samples of thermal break materials in accordance with the following requirements:
 - a. Provide minimum two square feet on representative substrate, where directed by the Architect, for each different thickness and finish of required for the work.
 - b. Provide mock-up areas that comply with thickness, density application, finish texture, and color.
 - c. Inspect mock-up areas within one hour of application for variance due to shrinkage, temperature, and humidity.
 - d. Where shrinkage and cracking are evident, adjust mixture and method of application as necessary to meet required installation, finish, and color requirements.
 - e. Continue to provide mock-up areas until acceptable areas are produced.
 - f. Acceptable areas shall constitute standard of acceptance for method of application, thickness, finish texture, and color requirements, for fluid applied thermal break material applications.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver materials in manufacturers' original, sealed, undamaged container with identification label intact. Packaged materials shall bear the appropriate labels, seals.
- B. Storage: Materials shall be stored in strict accordance with manufacturers documented instructions.
- C. Documentation: All batch number, product identification and quantities shall be recorded on appropriate QC documents. A copy of the transport document and manufacturers conformance certificate shall be attached to the material delivery on site.

1.9 PROJECT/SITE CONDITIONS

- A. Project Environmental Requirements: Substrate and air temperature shall be in accordance with the manufacturers' requirements.
 1. Protect work area from windblown dust and rain. Protect adjacent areas from over spray of material.
 2. Provide ventilation in areas to receive work of this section during application and minimum 24 hours after application.
- B. Temperature and Humidity Requirements: Maintain air temperature and relative humidity in areas where products will be applied for a time period before during and after application as recommended by manufacturer.
 1. Do not apply Fluid Applied Acrylic Thermal Break when temperature of substrate and/or surrounding ambient air temperature is below 45° F. Temporary protection and heat shall be maintained at this minimum temperature for 24 hours before, during and 24 hours after material application.
 2. Steel substrate temperature shall be a minimum of 5° F (3° C) above the dew point of the surrounding air for a period of 24 hours prior, during the application of the material and 24 hour cure period.
 3. If necessary for job schedule, the Prime General Contractor shall provide enclosures and heat to maintain proper temperatures and humidity levels in the application areas.
 4. The relative humidity of the application area shall not exceed a maximum of 85% 24 hours prior, during and 24 hours after the application of the material. The relative humidity shall not exceed 75% throughout the application and curing of the decorative top coat finish.

PART 2 PRODUCTS

2.1 LEED MATERIAL REQUIREMENTS

- A. Products and materials in this Section shall meet performance criteria and contribute to sustainable design requirements, as specified in Section 01 81 13 (Sustainable Design Requirements). These contributions include, but are not limited to, preconsumer and postconsumer recycled content percentages, regional content percentages, FSC Certified wood, and product VOC content limits.
- B. VOC Limits: Products and materials shall comply with VOC limits as specified in Section 01 81 13 (Sustainable Design Requirements).

2.2 FLUID APPLIED INSULATION COATING GENERAL

- A. Materials Compatibility:
 - 1. Provide shop and field primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 - 2. Provide products of same manufacturer for each coat in a coating system.

2.3 MANUFACTURERS

- A. Products specified are manufactured by Tnemec Company Incorporated, 6800 Corporate Drive, Kansas City, Missouri 64120-1372, 1-800-TNEMEC-1, www.tnemec.com, ist@tnemec.com, and are specified as a standard of quality.
 - 1. Provide "Series 971 Aerolon Acrylic" fluid-applied acrylic insulation and compatible primers, or products that meet or exceed the physical and performance requirements of the specified product.

2.4 PRIMERS

- A. Water-Based Cementitious Epoxy:
 - 1. Tnemec Series 1224 Epoxoline WB
 - a. VOC Content: 1 gram/liter
 - b. Color: 1288 Off-White
 - c. Requirements:
 - 1) Abrasion (((ASTM D4060))) : No more than 149 mg loss after 1,000 cycles.
 - 2) Adhesion to Steel (((ASTM D4541))) : No less than 1,989 psi after 10 freeze/thaw cycles.
 - 3) Humidity Resistance (ASTM D4585): No blistering, cracking, rusting, or delamination after 2,000 hours.
 - 4) CDPH Compliant: Passes the California Department of Public Health (CDPH) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, Version 1.1-2010 (also known as Section 01350).
- B. Zinc-Rich Aromatic Urethane:
 - 1. Tnemec Series 90-97 Tneme-Zinc®
 - a. VOC Content: 321 grams/liter
 - b. Color: 90-97 Reddish Gray
 - c. Requirements:
 - 1) Adhesion to Steel (((ASTM D4541))) : No less than 2,083 psi.
 - 2) Salt Spray (((ASTM B117))) : No blistering, cracking or delamination of film. No more than 1/8" rust creepage at scribe and no more than 1% rusting on plane after 50,000 hours exposure.

2.5 THERMAL INSULATING COATING

- A. Fluid Applied Acrylic Insulation Coating
 - 1. Tnemec Series 971 Aerolon Acrylic
 - a. VOC Content: 1.9 grams/liter
 - b. Solids by Volume: 76 percent.
 - c. Colors: 1278 Insulation Yellow
 - d. Dry Film Thickness: 30.0 to 50.0 mills per coat.
 - e. Total Thickness: Minimum of 100.0 mils providing an R value of 0.40 unless noted otherwise.
 - f. Requirements:
 - 1) Abrasion (((ASTM D4060))): No more than 50.2 mg loss after 1,000 cycles.
 - 2) Cyclic Salt Fog/UV Exposure (ASTM D5894): No blistering, cracking, rusting or delamination of film after 5,000 hours.
 - 3) Humidity Resistance (ASTM D4585): No blistering, cracking, rusting, or delamination after 2,000 hours.
 - 4) Immersion (ASTM D870): No blistering, cracking, rusting, or delamination after six months continuous tap water immersion.
 - 5) Surface Burning Characteristics (((ASTM E84))): Class A
 - 6) Thermal Conductivity (((ASTM C518))): No greater than 0.2468 BTU-in/ft²-hr-°F.
 - 7) NORSOK M-501 ISO 20340: Passed 25 cycles.
 - 8) CDPH Compliant: Passes the California Department of Public Health (CDPH) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, Version 1.1-2010 (also known as Section 01350).

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. All surfaces to receive the specified Tnemec Series 971 Aerolon® shall follow the manufacturer's printed instructions and be clean, dry and free of oil, grease, loose mill scale, dirt, dust or other foreign substances which would impair bond of the material to the substrate.
- D. Other corrections of the surfaces to receive the Fluid Applied Insulation Coating material shall be the responsibility of the Contractor, at no additional cost to the Owner.
- E. Application of the primer, Series 971 Aerolon®, and topcoat shall not commence until the contractor, applicator and inspector have examined the surfaces to receive the primer and determined the surfaces are acceptable to receive the primer and Aerolon®. Commencement of application means acceptance of substrate.
- F. Verify that substrate and workspace temperature and humidity conditions are in accordance with manufacturers recommendations.

3.2 SURFACE PREPARATION

- A. Prepare surfaces in accordance with manufacturer's instructions.

- B. Provide masking, drop cloths or other suitable coverings to prevent overspray onto surfaces not intended to be coated with thermal break coating.
- C. Weld spatter and defects shall be ground smooth prior to commencement of primer and fluid applied thermal break material.
- D. Primer shall not be applied to prepared substrate until the area has been adequately vented to remove all airborne dust. Prior to the application of any coating material, the blast products, dust and debris shall be removed by vacuuming.
- E. Steel Substrates: Remove rust and loose mill scale.
 - 1. Fabrication defects:
 - a. Correct steel and fabrication defects revealed by surface preparation.
 - b. Remove weld spatter and slag.
 - c. Round sharp edges and corners of welds to a smooth contour.
 - d. Smooth weld undercuts and recesses.
 - e. Grind down porous welds to pinhole-free metal.
 - f. Remove weld flux from surface.
 - 2. Ensure surfaces are dry.
 - 3. Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 6/NACE 3, unless otherwise specified.
- F. Abrasive Blast-Cleaned Surfaces: Coat abrasive blast-cleaned surfaces with primer before visible rust forms on surface. Do not leave blast-cleaned surfaces uncoated for more than 8 hours.
 - 1. Shop Primer: Prepare shop primer to receive field coat in accordance with manufacturer's instructions.

3.3 APPLICATION

- A. Apply coatings in accordance with manufacturer's instructions.
 - 1. Mix and thin coatings, including multi-component materials, in accordance with manufacturer's instructions.
 - 2. Keep containers closed when not in use to avoid contamination.
 - 3. Do not use mixed coatings beyond pot life limits.
 - 4. Use application equipment, tools, pressure settings, and techniques in accordance with manufacturer's instructions.
- B. Uniformly apply coatings at spreading rate required to achieve specified DFT.
- C. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.
- D. Apply primer at thickness recommended by manufacturer.
- E. Apply Series 971 Aerolon® Thermal Insulative Coating as specified in Section 3.8 Coating Schedule.
- F. Final Dry Film Thickness (DFT) shall be measured with a dry film thickness gauge.
- G. The steel deck is not to be sprayed unless otherwise indicated.

3.4 REPAIR

- A. Materials and Surfaces Not Scheduled to Be Coated: Repair or replace damaged materials and surfaces not scheduled to be coated.

- B. Damaged Coatings: All patching and repair to material, due to damage by other trades, shall be performed under this section and paid for by the trade responsible for the damage. Patching shall be performed by applicators certified by the manufacturer and applied in accordance with the manufacturer application instructions.
- C. Coating Defects: Repair in accordance with manufacturer's instructions coatings that exhibit film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.5 FIELD QUALITY CONTROL

- A. The Owner will engage an independent testing laboratory inspect and verify the application of material in accordance with the provisions Tnemec Company.
 - 1. Material inspection and testing shall be performed 24 hours after completion of final application coat.
 - 2. The results of the above tests shall be made available to all parties at the completion of each pre-designated area and approval.
 - 3. In-place material not in compliance with the specified thickness requirements shall be corrected prior to final acceptance.
- B. The dry film thickness (DFT) of the applied material shall be measured with a non-destructive coating thickness gage after material has completely cured. All measurements shall be documented in writing and furnished to the Owner.
- C. Manufacturer's Technical Services: Coordinate with coating manufacturer's technical service department or independent sales representative for current technical data and instructions.

3.6 CLEANING AND PROTECTION

- A. Remove overspray materials from surfaces not required to be thermally protected.
- B. Protect surfaces of coating systems from damage during construction.
- C. Touch-up, or repair damaged products before Substantial Completion.

3.7 ONE-YEAR INSPECTION

- A. Owner will set date for one-year inspection of coating systems.
- B. Inspection shall be attended by Owner, Contractor, Architect, and manufacturer's representative.
- C. Repair deficiencies in coating systems as determined by Architect in accordance with manufacturer's instructions.

3.8 FLUID APPLIED INSULATION COATING SCHEDULE

- A. Steel Members Penetrating Exterior Building Envelope/Inside Face of Metal Framing with a Physical Thermal Break, Condensation Control:
 - 1. Fluid Applied Thermal Break System, Water-Based:
 - a. Surface Preparation: SSPC-SP6/NACE 3
 - b. Prime Coat (Shop or Field): Series 1224 Epoxoline WB, DFT of 4.0 to 10.0 mils per coat.
 - c. Intermediate Coat (Shop or Field) – Two Coats: Series 971 Aerolon Acrylic, DFT of 50.0 mils per coat. Total thickness of Series 971: 100 mils.
 - d. Apply to steel penetrating the exterior envelope without a physical thermal break, from 24 inches outboard of the face of the wall to 24 inches inside the face of metal framing.
 - 2. Fluid Applied Thermal Break System, Zinc-Rich MCU Primer:
 - a. Surface Preparation: SSPC-SP6/NACE 3
 - b. Prime Coat (Shop or Field): Series 90-97 Tneme-Zinc, DFT of 2.5 to 3.5 mils per coat.

- c. Intermediate Coat (Shop or Field) – Two Coats: Series 971 Aerolon Acrylic, DFT of 50.0 mils per coat. Total thickness of Series 971: 100 mils.
- d. Apply to steel penetrating the exterior envelope without a physical thermal break, from 24 inches outboard of the face of the wall to 24 inches inside the face of metal framing.

END OF SECTION 09 96 72

SECTION 10 14 00
SIGNAGE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Non-illuminated interior room signage.

1.2 REFERENCES

- A. Standards of the following as referenced:
- B. American National Standards Institute (ANSI).
- C. Industry standards:
 - 1. Department of Justice, Office of the Attorney General, "Americans with Disabilities Act", Public Law 101-336, (ADA).
 - 2. ANSI A117.1: Providing Accessibility and Useability for Physically Handicap People, 1986 edition.

1.3 DEFINITIONS

- A. Terms:
 - 1. Braille: Grade 2 Braille including 189 part-word or whole word contractions in addition to Grade 1 Braille 63 characters. Tactile is required whenever Braille is required; see SYSTEM DESCRIPTION article below.
 - 2. Non-tactile: Letters and numbers on signs with width-to-height ratio between 3:5 and 1:1 and stroke width ratio between 1:5 and 1:10 using upper case "X" to calculate ratios. Use typestyles with medium weight; upper and lower case lettering is permitted; serif typestyles are permitted. See SYSTEM DESCRIPTION article below.
 - 3. Symbols: Symbol itself is not required to be tactile but equivalent verbal description is required both in tactile letters and Braille.
 - 4. Tactile: 1/32" raised capital letters without serifs at least 5/8" height and not more than 2" height based on upper case "X". Braille is required whenever tactile is required; see SYSTEM DESCRIPTION article below.

1.4 SYSTEM DESCRIPTION

- A. Signage under this section is intended to include items for identification, control, and information of building where installed as complete integrated system from a single manufacturer.
- B. ADA Design Requirements:
 - 1. Signage requiring tactile graphics:
 - a. Wall mounted signs designating permanent rooms and spaces such as, room numbers and restroom, department, office, and fire exit identifications.
 - b. Individually applied characters are prohibited.
- C. ADA performance requirements:
 - 1. Tactile graphics signs mounting requirements:
 - a. Single doors: Mount 60" to sign centerline above finish floor and on wall adjacent to latch side of door.
 - b. Openings: Mount 60" to sign centerline above finish floor adjacent opening.
 - c. No wall space adjacent latch side of door, opening, or double doors: Mount 60" to sign centerline above finish floor on nearest adjacent wall.

- d. See attached typical interior signage locations.

1.5 SUBMITTALS

- A. Product data:
 - 1. Manufacturer's signed statement regarding compliance with QUALITY ASSURANCE article.
 - 2. Manufacturer's product literature indicating units and designs selected.
 - 3. Evidence of manufacturer's computerized data retrieval program for tracking of project for sign typography, message strip requirements and other pertinent data from schedule input to final computerized typography on finished product.
- B. Shop drawings:
 - 1. Indicate materials, sizes, configurations, and applicable substrate mountings.
 - 2. Signage schedule complete with location of each sign and required copy; include floor plans.
 - 3. Final room names and numbers will not match those indicated in contract documents. Submittals of finalized names and numbers must be approved in writing by Owner prior to fabrication.
- C. Samples: Full size samples for holder, insert, and copy in colors specified. Provide sample in small size sign. Samples will not be returned for use in Project.
- D. Manufacturer has available software program for personal computers, called "signword pro" enabling end user to produce graphics on insert or sign face.
- E. Contract close out:
 - 1. Furnish appropriate checklist for aiding in reordering after Date of Substantial Completion.
 - 2. Maintenance data and cleaning requirements for exterior surfaces.
 - 3. Furnish one complete SignWord software package Windows 3.0 or Windows 95 or later, Windows NT 4.0 or later in Owner selected format for PC type computer.
 - 4. Furnish SignWord Color paper system

1.6 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer:
 - a. Work required under this section from manufacturers regularly engaged in work of this magnitude and scope for minimum of five years.
 - b. Maintain computer link between schedule input and computerized typography production.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance at site: Coordinate delivery of work to Project site under this section for immediate installation.

1.8 SEQUENCING AND SCHEDULING

- A. Schedule system installation after related finishes have been completed.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

- A. Acceptable product:
 - 1. APCO; FullView Display System; 17 Jennycliffe Lane, St. Louis, MO 63005.

2. Standard Assembly – Combination of extruded aluminum components, composite aluminum sheet and injection molded components, creating modular signs with a special, concealed pin lock device to secure a clear cover and/or sign insert material into the frame. Possible sign inert/display combinations include:
 - a. Non-Glare Acrylic Lens with Subsurface Paper Insert/Digital Output Display
 - b. ADA (Tactile/Braille) Plaques
3. Assembly allows for flexibility of size and configuration, providing a modular, vandal-resistant solution for signs ranging from single-insert identification signs to large directories and directional signs.
 - a. Surface Mounted Signs (Wall): Attachment to wall surfaces via or concealed mechanical fasteners.

2.2 FULL VIEW DISPLAY SYSTEM

- A. Modular Sign System with tamper proof locking pin for sign types: name plate, room/floor identification, directional use:
 1. Standard Sizes (acrylic lens dimensions shown):
 2. Vertical Edge Configurations – Surface Mount: (aluminum edge profiles at left/right of sign)
 - a. Sign Type A:
 - 1) FVS5585(V). 5.5" height x 8.5" wide. Standard Assembly
 - 2) " x 8.5" Novacryl Clear ADA Photopolymer with room number tipped A01 white.
 - 3) Right color band, sub surface silkscreened, A 54 Graphite. Building name masked off so paper color shows through.
 - 4) (glued on letters and Braille, Braille strips and engraving or routing to achieve raised lettering and Braille is prohibited).
 - 5) Paper insert by client.
 - 6) Mechanical Mounting holes.
 - 7) NMS-4 Notifier bar below to hold notes. 8.5" length, natural satin finish.
 - b. Sign Type B:
 - 1) FVS0806(V). 8" height x 6" wide. Standard Assembly
 - 2) FullView aluminum holder, Square profile.
 - 3) 8" x 6" Novacryl Clear ADA Photopolymer with room name and symbols tipped A01 white.
 - 4) Sub surface background color, A 54 Graphite.
 - 5) (glued on letters and Braille, Braille strips and engraving or routing to achieve raised lettering and Braille is prohibited).
 - 6) Mechanical Mounting holes.
 3. Color: Selected by Architect from manufacturer's standard NS-Natural Satin anodized (204R1)
 4. Select from Edge Shapes: Square
 5. Select Mounting Wall Signs: MF – Mechanical Fasteners
- B. Graphics:
 1. Type sizes: Selected from manufacturer's standard sizes indicated in SCHEDULES article for particular units; meet ADA requirements for letter proportions and sizes. Clear coating on ADA bands or painted and tipped surfaces as required in SCHEDULES article.
 - a. (ARN) Arial Narrow

2.3 FABRICATION

- A. Shop assembly:
 - 1. Fabricate units to configurations indicated on reviewed shop drawings. Internally reinforce units in accord with reviewed shop drawings.
 - 2. Wrap each individual unit with polyethylene. Provide special Suction Cup Removal Tool (SCT) and Locking Pin removal tool.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install signage holders in locations with mounting types indicated in accord with reviewed shop drawings. Square, plumb, and level units.
- B. Install inserts not more than 48 hours prior to Date of Substantial Completion complete with correct copy in place. Conform to ADA requirements for tactile graphics signage.
- C. Provide brushed aluminum backup plate to match sign size on the back of the glass where room signs are installed on glass units.

3.2 CLEANING

- A. Clean exposed surfaces not more than 48 hours prior to Date of Substantial Completion in accord with manufacturer's written cleaning instructions.

3.3 SCHEDULES

- A. See attached sheet for Schedule.

END OF SECTION 10 14 00

SECTION 10 14 16
PLAQUES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Plaques.

1.2 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For plaques.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show plaque mounting heights, locations of supplementary supports to be provided by others, and accessories.
 - 3. Show message list, typestyles, graphic elements, and layout for each plaque at least full size.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Plaque Schedule: Use same designations specified or indicated on Drawings or in a plaque or sign schedule.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample warranty.

1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of plaques that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PLAQUES

- A. Etched Plaque: Chemically etched or photochemically engraved metal sheet or plate with texture, border, and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
 - 1. 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. A.R.K Ramos.
 - b. APCO Graphics, Inc.
 - c. Gemini Incorporated.
 - d. Metal Arts.
 - 2. Plaque Material: Sheet or plate bronze.
 - 3. Plaque Thickness: 0.250 inch.
 - 4. Plaque Size: 1' 6" wide by 3'-0" tall.
 - 5. Finishes:
 - a. Integral Finish: Clear anodized.

- b. Overcoat: Manufacturer's standard baked-on clear coating.
- 6. Integral Edge Style: Square cut, polished.
- 7. Mounting: Concealed studs.
- 8. Plaque graphic template to be provided by Architect.

2.2 MATERIALS

- A. Aluminum Sheet and Plate: ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

2.3 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of plaques, noncorrosive and compatible with each material joined, and complying with the following:
 - 1. Use concealed fasteners and anchors unless indicated to be exposed.
 - 2. Exposed Metal-Fastener Components, General:
 - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
 - 3. Plaque Mounting Fasteners:
 - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of plaque, screwed into back of plaque, or screwed into tapped lugs cast integrally into back of plaque, unless otherwise indicated.

2.4 FABRICATION

- A. General: Provide manufacturer's standard plaques according to requirements indicated.
 - 1. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 - 2. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 3. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match plaque finish.
 - 4. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.
- B. Surface-Engraved Graphics: Machine engrave characters and other graphic devices into panel surface indicated to produce precisely formed copy, incised to uniform depth.
 - 1. Engraved Metal: Fill engraved graphics with manufacturer's standard baked enamel.
- C. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted plaques to suit plaque construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.
 - 1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish to match plaque-background color unless otherwise indicated.

2.5 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of plaque work.
- B. Verify that plaque-support surfaces are within tolerances to accommodate plaques without gaps or irregularities between backs of plaques and support surfaces unless otherwise indicated.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install plaques using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install plaques level, plumb, true to line, and at locations and heights indicated, with plaque surfaces free of distortion and other defects in appearance.
 - 2. Install plaques so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that plaque surfaces are clean and free of materials or debris that would impair installation.
 - 4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Mounting Methods:
 - 1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of plaque. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place plaque in position and push until flush to surface, embedding studs in holes. Temporarily support plaque in position until adhesive fully sets.
 - b. Thin or Hollow Surfaces: Place plaque in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed plaques and plaques that do not comply with specified requirements. Replace plaques with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as plaques are installed.
- C. On completion of installation, clean exposed surfaces of plaques according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain plaques in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 10 14 16

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SECTION 10 14 19
DIMENSIONAL LETTER SIGNAGE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Cast dimensional characters at interior locations.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, and layout for each sign at least half size.
- C. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
 - 1. Dimensional Characters: Full-size Sample of each type of dimensional character.
 - 2. Exposed Accessories: Full-size Sample of each accessory type.
 - 3. Full-size Samples, if approved, will be returned to Contractor for use in the Project.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer of products.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Separation or delamination of sheet materials and components.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 DIMENSIONAL CHARACTERS

- A. Cast Characters : Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:
 - 1. [Basis-of-Design Product](#): Subject to compliance with requirements, provide A.R.K. Ramos; or comparable product by one of the following:

- a. ACE Sign Systems, Inc.
 - b. ASI Sign Systems, Inc.
 - c. Gemini Incorporated.
2. Character Material: Cast aluminum (Craig Hall)
3. Character Material: Cast bronze (Art Annex).
4. Font Style: ROFFE 515.
5. Character Height: See drawings.
6. Thickness: 1"
7. Finishes:
 - a. Clear Anodized
8. Mounting: Concealed fastener, projecting studs/mounts with 1/2" standoff unless otherwise noted on drawings.

2.2 DIMENSIONAL CHARACTER MATERIALS

- A. Aluminum Castings: ASTM B26/B26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.

2.3 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
 1. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
 2. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.

2.4 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
 6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

7. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

2.5 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. 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.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.6 ALUMINUM FINISHES

- A. Color Anodic Finish: AAMA 611, Class I, 0.018 mm or thicker.

2.7 BRONZE FINISHES

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Verify that electrical service is correctly sized and located to accommodate signs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DIMENSIONAL CHARACTERS

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Mounting Methods:
 1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.

- b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
 2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
 - b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.
 3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
 4. Back Bar and Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position, so that signage is correctly located and aligned.
 5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
 6. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 10 14 19

SECTION 10 21 13.17
PHENOLIC TOILET COMPARTMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Phenolic toilet compartments.
- B. Urinal screens.

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

- A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.

1.4 ADMINISTRATIVE REQUIREMENTS

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on panel construction, hardware, and accessories.
- C. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall supports, door swings.
- D. Samples: Submit two samples of partition panels, 6 by 6 inch in size illustrating panel finish, color, and sheen.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Phenolic Toilet Compartments:
 - 1. ASI Accurate Partitions; ____: www.asi-accuratepartitions.com/#sle.

2.2 PHENOLIC TOILET COMPARTMENTS

- A. Toilet Compartments: Factory fabricated doors, pilasters, and divider panels made of solid phenolic core panels with integral melamine finish, floor-mounted headrail-braced.
 - 1. Color: Type 1 - Craig Hall - Hazelnut #4450C.
 - 2. Color: Type 2 - Art Annex - Fog #3450C.
- B. Doors:
 - 1. Thickness: 3/4 inch.
 - 2. Width: 24 inch.
 - 3. Width for Handicapped Use: 36 inch.
 - 4. Height: 58 inch.
- C. Panels:
 - 1. Thickness: 1/2 inch.
 - 2. Height: 58 inch.
 - 3. Depth: As indicated on drawings.
- D. Pilasters:
 - 1. Thickness: 3/4 inch.

2. Width: As required to fit space; minimum 3 inch.
- E. Screens: Without doors; to match compartments; mounted to wall with two panel brackets with vertical support/bracing same as compartments.

2.3 ACCESSORIES

- A. Pilaster Shoes: Formed ASTM A666 Type 304 stainless steel with No. 4 finish, 3 inch high, concealing floor fastenings.
 1. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster.
- B. Head Rails: Hollow anodized aluminum, 1 inch by 1-1/2 inch size, with anti-grip profile and cast socket wall brackets.
- C. Wall and Pilaster Brackets: Polished stainless steel; manufacturer's standard type for conditions indicated on drawings.
- D. Attachments, Screws, and Bolts: Stainless steel, tamper proof type.
 1. For attaching panels and pilasters to brackets: Through-bolts and nuts; tamper proof.
- E. Hardware: Polished stainless steel:
 1. Pivot hinges, gravity type, adjustable for door close positioning; two per door.
 2. Door Latch: Slide type with exterior emergency access feature.
 3. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
 4. Coat hook with rubber bumper; one per compartment, mounted on door.
 5. Provide door pull for outswinging doors.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify correct spacing of and between plumbing fixtures.
- C. Verify correct location of built-in framing, anchorage, and bracing.

3.2 INSTALLATION

- A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
- B. Maintain 3/8 inch to 1/2 inch space between wall and panels and between wall and end pilasters.
- C. Attach panel brackets securely to walls using anchor devices.
- D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.
- E. Field touch-up of scratches or damaged finish will not be permitted. Replace damaged or scratched materials with new materials.

3.3 TOLERANCES

- A. Maximum Variation From True Position: 1/4 inch.
- B. Maximum Variation From Plumb: 1/8 inch.

3.4 ADJUSTING

- A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.
- B. Adjust hinges to position doors in partial opening position when unlatched. Return out-swinging doors to closed position.
- C. Adjust adjacent components for consistency of line or plane.

END OF SECTION 10 21 13.17

SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.
- C. Accessories.

1.2 REFERENCE STANDARDS

- A. NAAMM AMP 510 - Metal Stairs Manual; 1992.
- B. NFPA 10 - Standard for Portable Fire Extinguishers; 2022.
- C. UL (DIR) - Online Certifications Directory; Current Edition.

1.3 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide extinguisher operational features.
- C. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.

1.5 WARRANTY

- A. A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: **Five** years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Fire Extinguishers:
 - 1. Activar Construction Products Group, Inc. - JL Industries: www.activarcpg.com/#sle.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Fire Extinguisher Cabinets and Accessories:
 - 1. Activar Construction Products Group, Inc. - JL Industries: www.activarcpg.com/#sle.
 - 2. Larsen's Manufacturing Co: www.larsensmfg.com/#sle.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
 - 1. Provide extinguishers labeled by UL (DIR) for purpose specified and as indicated.

- B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
 - 1. Class: UL-rated 2A-10B:C type.
 - 2. Size: 5 pound.
 - 3. Valve: Aluminum.
 - 4. Finish: Baked polyester powder coat, manufacturer's standard red color.
 - 5. Temperature range: Minus 40 degrees F to 120 degrees F.

2.3 FIRE EXTINGUISHER CABINETS

- A. Recessed Cabinet, Horizontal Orientation:
 - 1. Location: **See Drawings.**
 - 2. Orientation: Horizontal; Set cabinet in wall construction with long edge parallel to flooring. Field verify top of extinguisher is not more than 60" above finished floor.
 - 3. Cabinet Construction: Non-fire rated.
 - a. Formed primed steel sheet; 0.036 inch thick base metal.
 - 4. Trim: Flat trim, with 3/8 inch wide face.
 - 5. Door: Solid.
 - 6. Pull: Theft-deterrent, pull handle.
 - 7. Finish: Powder coated, manufacturer's standard white.
 - 8. Text: Red horizontal letters stating "FIRE EXTINGUISHER".
- B. Surface Mounted Cabinet:
 - 1. Location: **See Drawings.**
 - 2. Cabinet Construction: Non-fire rated.
 - a. Formed primed steel sheet; 0.036 inch thick base metal.
 - 3. Trim: Surface mount.
 - 4. Door: Solid.
 - 5. Pull: Theft-deterrent, pull handle.
 - 6. Finish: Powder coated, manufacturer's standard white.
 - 7. Text: Red vertical letters stating "FIRE EXTINGUISHER".

2.4 ACCESSORIES

- A. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

2.5 FABRICATION

- A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 - 1. Weld joints and grind smooth.
- B. Cabinet Doors: 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 thick.
 - 2. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.6 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM AMP 510's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire protection cabinets after assembly.
- D. 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.

2.7 STEEL FINISHES

- A. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond using manufacturer's standard methods.
- B. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify rough openings for cabinet are correctly sized and located.
- C. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged units.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install cabinets plumb and level in wall openings, 60 inches from finished floor to inside top of cabinet, unless noted otherwise.
- C. Secure rigidly in place.
- D. Place extinguishers in cabinets.

3.3 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.
- E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 44 00

SECTION 11 05 00
COMMON REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Section includes general requirements for manufacturer shop equipment for field installation.

1.2 COORDINATION

- A. Coordinate equipment layout and installation with other work, including layout and installation of light fixtures, HVAC equipment, and fire-suppression system components.
- B. Coordinate locations and requirements of utility service connections.
- C. Coordinate sizes, locations, and requirements of the following:
 - 1. Exhaust
 - 2. Dust Collection
 - 3. Compressed Air
 - 4. Power needs
- D. Coordinate proper ambient and environmental conditions are in place at time of equipment delivery and installation

1.3 PERFORMANCE REQUIREMENTS

- A. The basis of design products as indicated in the drawings represent the Owners preferred equipment selections based on performance, serviceability, and price. Bidders have the option to submit substitutions that meet or exceed the performance requirements indicated for each piece of equipment.
- B. The owner and architect reserve the right to reject any substitution request that does not meet the requirements outlined in the documents including, but not limited to: weight and physical dimensions.

1.4 SUBMITTALS

- A. Product Data: For each piece of equipment. Include the following:
 - 1. Manufacturer's model number
 - 2. Accessories and components that will be included in the project.
 - 3. Clearance requirements for access, operation, and maintenance.
 - 4. Utility service connections for water, drainage, power, and fuel; include roughing-in dimensions.
- B. Shop Drawings: For fabricated equipment. Include plans, elevations, sections, roughing-in dimensions, fabrication details, utility service requirements, and attachment to other work. Include plans, elevations, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 - 1. Indicate locations of equipment and connections to utilities.
 - 2. Key equipment using same designations as indicated on Drawings.
 - 3. Include plans and elevations; clearance requirements for equipment access and maintenance; details of equipment supports; and utility service characteristics.
- B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For equipment include operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Product Schedule: For each equipment item, include the following: Designation indicated on Drawings.
 - b. Manufacturer's name and model number.
 - c. List of factory-authorized service agencies including addresses and telephone numbers.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of construction contiguous with foodservice equipment by field measurements before fabrication. Indicate measurements on Coordination Drawings.

1.8 WARRANTY

- A. Warranty: Manufacturer agrees to repair or replace equipment or workmanship within specified warranty period.
 1. Warranty Period: Two years from date of Substantial Completion.

1.9 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. UL Certification: Provide electric and fuel-burning equipment and components that are evaluated by UL for fire, electric shock, and casualty hazards according to applicable safety standards, and that are UL certified for compliance and labeled for intended use.
- B. Basis of Design Product: Equipment as indicated in the drawings are preferred products based on physical dimensions, serviceability, and probable cost. Bidders may provide substitutions that meet or exceed the performance information provided. Owner and Architect reserve the right to reject substitutions that do not fully comply with the contract documents.
- C. Regulatory Requirements: Install equipment to comply with the following:
 1. NFPA 70, "National Electrical Code."

2.2 EQUIPMENT LIST

- A. See equipment schedule on sheet 2A1.11 within the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install equipment level and plumb, according to manufacturer's written instructions.
 1. Connect equipment to utilities.
- B. Complete equipment assembly where field assembly is required.
- C. Install equipment with access and maintenance clearances that comply with manufacturer's written installation instructions and with requirements of authorities having jurisdiction.

3.2 CLEANING AND PROTECTING

- A. After completing installation of equipment, repair damaged finishes.
- B. Clean and adjust equipment as required to produce ready-for-use condition.
- C. Protect equipment from damage during remainder of the construction period.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain equipment.

END OF SECTION 11 05 00

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SECTION 11 60 01
THEATER AND STAGE EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Theater and stage equipment including the following:
 - 1. Stage platforms.
 - 2. High-Density Portable Audience Chairs

1.2 RELATED SECTIONS

- A. Section 05 50 00 - Metal Fabrications.
- B. Section 06 10 00 - Rough Carpentry.
- C. Section 09 22 16.13 - Non-Structural Metal Stud Framing.

1.3 REFERENCES

- A. American Hardboard Association (AHA):
 - 1. AHA A135.4-95: Basic Hardboard.
- B. American Plywood Association (APA).
 - 1. Performance Standards and Policies for Structural Use Panels.
- C. American Society of Civil Engineers (ASCE):
 - 1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
- D. Architectural Woodwork Institute (AWI):
 - 1. Quality Manual, 8th Edition.
- E. ASTM International (ASTM):
 - 1. ASTM A36/A 36M - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A500 -Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 3. ASTM A513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.
 - 4. ASTM A1011 - 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.
 - 5. ASTM B85 - Standard Specification for Aluminum Alloy Die Castings.
 - 6. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - 7. ASTM B221 - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 8. ASTM B429 - Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - 9. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - 10. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 11. ASTM E 413 - Classification for Rating Sound Transmission.
- F. International Building Code (IBC).
 - 1. IBC 2018, Chapter 8.
- G. National Association of Architectural Metal Manufacturers (NAAMM): Metal Finishes Manual for Architectural and Metal Products.

- H. National Electrical Manufacturers Association (NEMA): NEMA LD 3-2000 - High Pressure Decorative Laminates.
- I. U.S. Department of Commerce, National Institute of Standards and Technology: DOC PS 1: U.S. Product Standard for Construction and Industrial Plywood.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Provide test results by certified independent testing laboratory indicating compliance with performance requirements.
 - 2. Rated capacities, construction details, material descriptions, dimensions of individual components, profiles, and finishes.
 - 3. Maintenance instructions and recommendations.
 - 4. Acoustical testing data demonstrating minimal compliance with required acoustical performance criteria.
 - 5. Photometric data for light fixtures, if applicable to the product.
- C. Shop Drawings:
 - 1. Submit component and project specific installation drawings, cut sheets, and schedules showing all information necessary to fully explain the design features, appearance, function, fabrication, installation, and use of system components in all phases of operation. Submit for approval before beginning any fabrication, installation, or erection.
 - 2. Include fabrication and installation details. Distinguish between factory and field work.
 - 3. Include plans, elevations, sections, attachments and work by other trades.
 - 4. Include wiring diagrams when applicable.
 - 5. Indicate seismic bracing and fastening requirements as applicable.
 - 6. For theater seating, develop sightline plan and sections through seating areas using sightlines program and sightline rules. Include options placement, electrical schematic for aisle lighting and placement of seating with table arms as applicable.
- D. Product Schedule:
 - 1. Use designations indicated on the Drawings.
 - 2. Include room locations, dimensions, accessories, finishes, and project specific notes.
- E. Verification Samples:
 - 1. Exposed Finishes and Finish Materials: Not less than 4 by 4 inches (102 by 102 mm), for each type, color, pattern, surface and material selected.
- F. Closeout Submittals:
 - 1. Operation and Maintenance Data: For adjusting, repairing and replacing components and accessories.
 - 2. Warranty: Submit manufacturer's warranty.
 - 3. As-Built Drawings: For completed work.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain all products from a single manufacturer through one source providing a comprehensive material and installation package:

- B. Manufacturer Qualifications: Minimum 5 years' experience in design and manufacturing of similar products on projects of similar size, scope and complexity, and with the production capacity to meet the construction and installation schedule.
- C. Installer Qualifications: ESTA-certified and experienced in installation of the work of this section and acceptable to the manufacturer and in the regular employ of the manufacturer.
- D. Electrical Components: Listed and labeled per NFPA 70, Article 100 by a testing agency acceptable to Authorities Having Jurisdiction (AHJ).
- E. Regulatory Requirements: Where components are indicated to comply with accessibility requirements, comply with the U.S. Architectural and Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities".

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original unopened containers with manufacturer's labels attached. Do not deliver material until spaces to receive them are clean, dry, and ready for their installation. Ship to jobsite only after roughing-in, painting and other finishing work has been completed, installation areas are ready to accept work.
- B. Handle and install materials to avoid damage.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install materials until spaces are enclosed and weather tight, wet work in spaces is complete and dry, HVAC system is operating and maintaining ambient temperature at occupancy levels during the remainder of the construction period.

1.8 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- C. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method; 2023.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- E. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. PS 1 - Structural Plywood; 2023.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Requests for substitutions shall be considered in accordance with provisions of Section 01 60 00 - Product Requirements.
 - 1. Manufacturers seeking approval shall submit the following:
 - a. Product data, including third-party certified acoustical data and proposed graphic/drawing layout for this project.

- b. Project references: Minimum of 5 installations not less than 3 years old, of comparable size, scope and complexity of this project, complete with owner contact information.
 - c. Sample warranty.
 2. Submit substitution request not less than required days prior to bid date.
 3. Approval shall be indicated by issuance of written Addendum.
 4. Approved manufacturers shall meet separate requirements of Submittals Article.
 5. Manufacturers' products that are either listed as pre-approved in these Specifications or who have been granted approval as an alternate must still demonstrate all of the material performance and operational characteristics required by this Section.

2.2 STAGE PLATFORMS

- A. Basis of Design: StageTek Platforms; portable stage platforms, seated risers, pit fillers and stage extensions as manufactured by Wenger Corporation.
- B. Structural Performance Requirements as measured on a 4 feet by 8 feet (1219 mm X 2438 mm) rectangular deck:
 1. Stage Platforms and Risers:
 - a. Standard Uniform Live Load for decks with 4 legs: 125 lbf/sq ft (6 kN/sq m), meets L/75 deflection criteria.
 2. Lateral Live Side Load: 12 lbf/sq ft (0.6 kN/sq m) based on deck top surface area, meets IBC code.
 3. Caster Load: 300 lb (136 Kg) applied via 2 inch (51 mm) diameter by 2 inch (51 mm) wide flat rubber wheel with no appreciable surface deformation.
 4. Concentrated Load: 500 lb (227 kg) on a single 6 inch (152 mm) by 6 inch (152 mm) square area per deck.
 5. Anchoring: Pit filler to be secured to stagefront edge with approved manufacturer components.
 6. Ledger Mount: Option available per project specific drawing using 4 or 5 legs.
 7. Stage Decks: Fully replaceable components including corners, frame, and wood deck. Replaceable in the field with common tools.
 8. Treads of Stairs: Uniform Load: 500 lb (227 Kg) per 36 inches x 11 inches (914 x 279 mm) tread, and concentrated load: 300 lb (136 Kg) on area of 12 sq in (7742 sq. mm): Total Uniform Load of 1,000 lb (454 Kg) per stair assembly.
 9. Guard Rail Concentrated Load: 200 lbf (0.89 kN) applied at any point in any direction.
 10. Guard Rail Uniform Load: 50 lbf/ft (0.73 kN/m) applied to top rail.
 11. Intermediate Rails, Panels, and Baluster Concentrated Load: 50 lbf (0.22 kN) applied to 1 sq ft (0.093 sq. m) area.
 12. Guard Rail In-Fill Panel compliant with IBC 4 inches (102 mm) sphere code.
- C. Materials:
 1. Aluminum: Complies with ASTM Standards listed above in section 1.3 C.
 2. Materials Meeting Sustainable Design Requirements:
 - a. Provide stage platforms and risers made with products and adhesives that contain no added urea formaldehyde.
 3. Softwood Plywood: DOC APA PS1.
 4. Hardboard: AHA A135.4, Tempered Grade.

5. Hardware and Fasteners: Manufacturer's standard non-corroding type, permanently mounted to units, remaining set or tightened under load and vibration in service, and designed to preclude user contact with sharp edges.
- D. Frame: Extruded 6063-T6 aluminum, 4 inches tall (102 mm), with hidden contours to accept attachments. Rounded 1.5 inches (38 mm) hand-hold area open to accept power-grip (closed-grip) around entire perimeter. Frame components are repairable and replaceable.
- E. Corners: Cast 380 aluminum corner assembly engages leg 3 inches (76.2 mm) and secures leg with a full-length 2.75 inches (69.85 mm) convex brace driven by a threaded bolt operated with a nylon t-handle. Corner assemblies are repairable and replaceable.
- F. Legs: Legs operate individually and are constructed of extruded 6063-T6 aluminum round tube, 2.50 inches diameter (63.5 mm) with a wall thickness of .075 inch (1.905 mm).
 1. Adjustable Legs: Provided where indicated. Legs provided with an adjustable threaded foot and jam nut for infinite adjustability plus or minus 2 inches (51 mm) from nominal length of leg. The foot shall provide a non-marking rubber pad.
- G. Deck Panels: Manufacturer's standard panel construction, 3/4-inch (19-mm) overall thickness, consisting of minimum 1/2-inch (12-mm) thick plywood substrate with finish surfaces consisting of, edged with extruded aluminum:
 1. Finish: Black 0.035 inch (0.89 mm) thick standard textured polypropylene with black smooth HDPE backer sheet.
 2. Panel Dimensions: Manufacturer's standard sizes, as required for layout indicated.
- H. Guards and Railings: Complying with performance requirements, clamp-attached without tools, lower horizontal rail acts as chair stop. Optional infill panels bring Guard Rails into compliance with International Building Code specifying that a 4 inches (102 mm) sphere object cannot pass through the railing.
- I. Stairs: Adjustable stair set, sized as required by platform layout, with handrails and slip-resistant treads.
- J. Box Step: Single relocatable box step equipped with clamps for fixing in place, height as required, located as indicated.
- K. Chair Stops:
 1. Clamp on leg stop, able to be installed and demounted without tools constructed of tube steel.
- L. Storage Cart: Steel tube-framed, folding transport cart with heavy-duty 8 inches (200 mm) casters and clamping safety strap. Provide number of carts required for layout indicated. Cart designed to carry up to 6 decks without accessories (5 decks with permanent chair stop) or 6 guardrails. Combinations of decks and guardrails can be stored on cart.
- M. Closure Panels: Closure panels matching Standard textured horizontal surface, not less than 3/4 inch (19 mm) thick plywood, secured with tool-free snap attachment located as follows:
 1. Front of unit.
 2. Sides of unit.
 3. Intermediate risers.
- N. Metal Finishes:
 1. Aluminum:
 - a. Painted frame, painted legs (except telescopic), mill finish on all other components.
 2. Steel: Powder-coated finish.
- O. Fabrication: Provide portable stages and risers meeting performance requirements, with the following characteristics:
 1. Portable and storable in space indicated.

2. Easily set up and disassembled without use of special tools or loose fasteners.
3. Modular and reconfigurable.
4. Platform components replaceable with common tools to include corners, frame sections, and platform decking.
5. Platforms supported by individual legs that are storable inside the platform frame.
6. Platforms designed for comfortable and secure power-grip (closed-grip) anywhere around entire deck perimeter.
7. Lightweight leg sets/understructures - 40 inches (1016 mm) tall or shorter weigh less than 10 lbs (4.5 kg).

2.3 PORTABLE AUDIENCE CHAIRS

- A. Basis of Design: High-Density Portable Audience Chairs as manufactured by Wenger Corporation.
 1. Style: Contour.
 2. Durable X-Frame design prolongs chair life and enhances comfort.
 3. Double tube and channel 18-gauge steel frame with 11-gauge K Brace.
 4. Frame finished: powder coat paint; black.
 5. Fabric: Vinyl
 - a. Color: Black.
 6. Padded Seat: 3" thick.
 7. Rubber, non-marring feet formed over flat steel inserts.
 8. Armrest: 2-arm versions.
 - a. Removable Standard Armrest.
 9. Size: 19.5" wide.
 10. Seat uplift: manual.
 11. Seat weight limit: 450 lb.
 12. Quantity: 150 seats.
- B. Storage Cart
 1. Double Tier Hanging Storage Cart
 - a. Dimensions: 89" long x 36.1" wide x 79" high (2261 x 917 x 2007 mm)
 - b. Capacities: 48 contour padded seat chairs.
 - c. Quantity: 3 for 150 seats.
 2. Removable Arm Cart
 - a. Dimensions: 58" long x 45" wide x 65" high (1473 x 1143 x 1651 mm)
 - b. Capacities: 144 arms

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine installation areas and mounting surfaces with Installer present, for compliance with manufacturer's installation tolerances including required clearances, floor level, location of blocking and anchoring reinforcements, and other existing conditions that may affect installation or performance.

- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Proceed with installation only after correction of unsatisfactory conditions.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION - GENERAL

- A. Install manufactured units in accordance with manufacturer's recommendations, approved submittals, and in proper relationship with adjacent construction.

3.4 INSTALLATION OF THEATER AND STAGE EQUIPMENT

- A. Install manufactured units in location indicated to verify components are complete and operational. Adjust equipment until satisfactory results are achieved.
- B. Acoustical Cloud Installation: Install auditorium acoustical cloud units plumb, level, and true, in accordance with manufacturer's recommendations and approved submittals. Suspend from overhead structure using specified installation accessories. Clean exposed surfaces of acoustical clouds. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

3.5 CLEANING AND PROTECTION

- A. Repair or replace defective work as directed by Architect upon inspection.
- B. Clean surfaces. Touch up marred finishes, or replace damaged components that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by manufacturer.
- C. Protect installed products from damage, abuse, dust, dirt, stain, or paint until completion of project. Do not permit use during construction.

END OF SECTION 11 60 01

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SECTION 11 60 00 – PERFORMANCE SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Curtains and Rigging Systems:
 - 1. Stage curtains and tracks.
 - 2. Rope and dead hung rigging.

1.2 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Rated capacities, construction details, material descriptions, dimensions of individual components, profiles, and finishes.
- C. Shop Drawings:
 - 1. Submit component and project specific installation drawings, cut sheets, and schedules showing all information necessary to fully explain the design features, appearance, function, fabrication, installation, and use of system components in all phases of operation. Submit for approval before beginning any fabrication, installation, or erection.
 - 2. Include fabrication and installation details. Distinguish between factory and field work.
 - 3. Include plans, elevations, sections, attachments and work by other trades.
 - 4. Include wiring diagrams when applicable.
 - 5. Indicate seismic bracing and fastening requirements as applicable.
- D. Coordination Drawings: Project-specific Coordination Drawings, indicating the following items drawn and coordinated with each other. Include information required by Installers of each item in order to coordinate the Work. Include the following:
 - 1. Relationship of items shown on separate Shop Drawings.
 - 2. Dimensions and required clearances of adjacent or related work.
 - 3. Order of assembly of separate items.
 - 4. Information required for interface with other trades and components, including mechanical, electrical, and communication work.
- E. Product Schedule:
 - 1. Use designations indicated on the Drawings.
 - 2. Include room locations, dimensions, accessories, finishes, and project specific notes.
- F. Verification Samples:
 - 1. Exposed Finishes and Finish Materials: Not less than 4 by 4 inches (102 by 102 mm), for each type, color, pattern, surface and material selected.
- G. Closeout Submittals:

1. Operation and Maintenance Data: For adjusting, repairing and replacing components and accessories.
 2. Warranty: Submit manufacturer's warranty.
 3. As-Built Drawings: For completed work.
- H. Field Quality Control Reports: Documenting inspections and demonstrations of installed products and equipment.

1.3 QUALITY ASSURANCE

- A. Curtain and Rigging Systems, Manufacturer Qualifications: Minimum 5 years experience in manufacture of similar products in use in similar environments, including project size, and complexity, and with the production capacity to meet the construction and installation schedule.
1. Theatrical rigging systems are specialized overhead lifting systems. Due to the highly specialized nature of theatrical rigging equipment, and the safety requirements of the equipment, the rigging products provided for this work shall be the products of a single rigging manufacturer for quality, consistency and ease of integration. Accessory items such as wire rope, fittings, and curtain tracks may be from other specialty manufacturers.
 2. The rigging manufacturer shall have the following programs in place.
 - a. The manufacturer shall have a product testing program, including determination of recommended working loads for products based on destructive testing and review by a licensed engineer.
 - b. The manufacturer of the performance equipment shall have a quality management system that is registered to the ISO 9001 standard.
 - c. The manufacturer shall carry primary product and general liability insurance of \$2,000,000 each, with excess liability coverage of \$10,000,000 and a Contractors Professional Liability policy with \$2,000,000 coverage.
- B. Rigging Systems, Installer Qualifications: Manufacturer's authorized representative, trained and approved for installation of units required for this Project.
1. The Rigging Contractor shall be an approved rigging manufacturer or an authorized representative or dealer of an approved manufacturer. The contractor shall have been installing stage rigging systems for a period of five years or more, and shall have completed at least ten installations of this type and scope. The AHJ shall be the final judge of the suitability of experience.
 2. The Rigging Contractor shall employ an Entertainment Technician Certification Program (ETCP) Certified Theatre Rigger. A Certified Rigger shall be either the project manager or site foreman, and be responsible for the overall project including the layout, inspection, and onsite user training.
- C. Rigging Systems, Minimum Standards of Safety, the following factors shall be used:
1. Cables and Fittings: 8:1 Safety Factor.
 2. Cable D/d ratio: Sheave tread diameter is the minimum D/d ratio per the "Wire Rope User Manual" or recommended by the wire rope manufacturer.
 3. Tread Pressures: 500 lbs. for cast iron, 900 lbs. for Nylatron, 1000 lbs. for steel.
 4. Maximum Fleet Angle: 1-1/2 degrees.
 5. Steel: 1/5 of yield strength or per AISC Specification.

6. Bearings: Two times required load at full speed for 2000 hours.
7. Bolts: Minimum SAE J429 Grade 5 (ISO R898 Class 8.8), zinc plated.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original unopened containers with manufacturer's labels attached. Do not deliver material until spaces to receive them are clean, dry, and ready for their installation. Ship to jobsite only after roughing-in, painting and other finishing work has been completed, installation areas are ready to accept work.
- B. Handle and install materials to avoid damage.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install materials until spaces are enclosed and weather tight, wet work in spaces is complete and dry, HVAC system is operating and maintaining ambient temperature at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Verify field measurements as indicated on Shop Drawings. Where measurements are not possible, provide control dimensions and templates.
 1. Coordinate installation and location of blocking and supports as requested.
 2. Verify openings, clearances, storage requirements and other dimensions relevant to the installation and final application.
 3. Where applicable, coordinate locations of electrical junction boxes.
- C. Field Measurements: Verify field measurements as indicated on Shop Drawings. Where measurements are not possible, provide control dimensions and templates.
 1. Coordinate locations of electrical junction boxes.
- D. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.6 WARRANTY

- A. Special Warranty for Curtain Systems: Provide manufacturer's standard limited 3 year warranty against defects in materials or workmanship from the date of Substantial Completion. The warranty is contingent on inspection of the equipment and training of its use being provided annually by an Entertainment Technician Certification Program (ETCP) Certified Theatre Rigger at the Owner's expense. It is the responsibility of the end user to make arrangements for the annual inspection and training. Failure to obtain the inspection and training annually shall result in a one year warranty. The warranty shall not cover equipment that has become defective due to misuse, abuse, accident, act of God, alteration, vandalism, ordinary wear and tear, improper maintenance, or used not in a manner intended.
- B. Special Warranty for Rigging Systems: Provide manufacturer's standard limited 3 year warranty against defects in materials or workmanship from the date of Substantial Completion. The warranty is contingent on inspection of the equipment and training of its use being provided annually by an Entertainment Technician Certification Program (ETCP) Certified Theatre Rigger at the Owner's expense. It is the responsibility of the end user to make arrangements for the annual inspection and training. Failure to obtain the inspection

and training annually shall reduce warranty coverage to one year after substantial completion. The warranty shall not cover equipment that has become defective due to misuse, abuse, accident, act of God, alteration, vandalism, ordinary wear and tear, improper maintenance, or used not in a manner intended.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Requests for substitutions shall be considered in accordance with provisions of Section 01 60 00 - Product Requirements.
 - 1. Manufacturers seeking approval shall submit the following:
 - a. Product data, including third-party certified acoustical data and proposed graphic/drawing layout for this project.
 - b. Project references: Minimum of 5 installations not less than 3 years old, of comparable size, scope and complexity of this project, complete with owner contact information.
 - c. Sample warranty.
 - 2. Submit substitution request not less than required days prior to bid date.
 - 3. Approval shall be indicated by issuance of written Addendum.
 - 4. Approved manufacturers shall meet separate requirements of Submittals Article.
 - 5. Manufacturers' products that are either listed as pre-approved in these Specifications or who have been granted approval as an alternate must still demonstrate all of the material performance and operational characteristics required by this Section.
- B. Rigging Systems, Requirements for Approval: Other equipment manufacturers seeking approval shall submit the following information at least 2 weeks prior to the bid opening date. Approval of manufacturers shall be by addenda. Failure to submit any of the required information shall automatically disqualify the manufacturers from consideration of approval.
 - 1. Evidence that the manufacturer has been in business for a minimum of ten years manufacturing stage equipment.
 - 2. A listing of 10 equivalent installations, including:
 - a. Name, address and telephone number of owner.
 - b. Name, address and telephone number of architect.
 - c. Scope of work.
 - 3. A brief written description of the manufacturer's operation including facilities, financial capabilities, and experience of key personnel.
 - 4. Written, third party evidence showing that the manufacturer has the testing, quality management and insurance programs required above in place.

2.2 STAGE CURTAINS

- A. Stage Curtains:
 - 1. Description and Sizes: As shown on drawings.
 - 2. Fabric Types:
 - a. Fabric: 25 oz. Charisma Velour, 100 percent polyester IFR velour, KM Fabrics, color - black.
 - 3. Flame Resistance:
 - a. All Polyester fabrics are woven from fibers that are inherently flame retardant for the life of the fabric. These curtains never need to be re-treated for flame

- retardancy.
 - b. 100 percent cotton fabrics are to be chemically mill treated by an immersion process. This process lasts approximately 5 years and then shall be re-done for flame retardancy according to the requirements of the National Fire Protection Association's NFPA #701 together with dry cleaning.
 - c. A Certificate of Flame Resistance is to be provided for each fabric supplied. The certificates shall be issued by the fabric manufacturer or converter. Certificates issued by the supplier or fabricator are not acceptable.
 - d. Each curtain is to be labeled with a permanent tag giving the flame retardancy information and providing a suggested date for testing, if applicable.
4. Fabrication:
- a. General: Curtains are to be fabricated in the sizes and fabrics shown in the curtain schedule. Curtains are to be stitched with thread matching the color of the curtain using a single needle lock stitched. No less than full widths of fabric are to be used in leg curtains. All fabrics with a grain or pile shall have all strips running in the same direction.
 - b. Fullness: Fullness shall be 50% and is to be in addition to allowances for seams, side hems and turn backs.
 - c. Pleats: Where fullness is indicated in the Curtain Schedule, pleats shall be box type on 12 inch (305 mm) centers.
 - d. Top Finish: 3-1/2 inch (89 mm) jute webbing or 3 inch (76 mm) Poly webbing shall be double stitched to the top of the curtain with 2 inch (50.8 mm) of face fabric turned under the webbing. Brass rustproof grommets shall be inserted in pleat centers (12 inch (305 mm)) centers on flat curtains.
 - e. Track-mounted curtains shall be supplied with plated wire S-hooks or CCF-2 curtain to carrier snap hooks. Batten-mounted curtains are to be supplied with 36 inch (914 mm) braided #4 cotton tie lines. Tie lines shall be black or white to best match the curtains with the center line in an alternate color to aid in hanging curtains.
 - f. Bottom Hems:
 - 1) Valances and borders shall have 4 inch (102 mm) bottom hems.
 - 2) All full height curtains shall have 6 inch (152 mm) bottom hems complete with separate interior chain pockets filled with #8 plated jack chains. Chain pockets shall be stitched so that the chain shall ride 2 inch (51 mm) above the finished bottom edge of the curtain.
 - 3) Scrims, drops and cycloramas shall have an additional strip of webbing with ties on 12 inch (305 mm) centers sewn to the back of the hem and shall be furnished with a 3/4 inch (19 mm) pipe batten, threaded and coupled every 10 feet-0 inch (305 mm).
 - g. Side Hems:
 - 1) All lined traveler curtains shall have 1/2 width of face fabric turned back at the leading edge.
 - 2) All other side hems shall be 2 inch (51 mm).
 - h. Lining: Lining, if required in the above listing, shall conform to the following requirements.
 - 1) Lining shall be in the same fullness as face fabric.
 - 2) Lining shall finish 2 inch (51 mm) shorter than face fabric.
 - 3) Lining shall be attached to the face fabric along the sides and bottom

hems by 4 inch (102 mm) twill tape.

2.3 DEAD HUNG RIGGING

A. Pipe Grid:

1. Pipe grids shall be constructed from lengths of 1.5 inches (38.1 mm) nominal I.D. schedule 40 iron pipe. All joints shall be sleeve spliced with 18 inches (457.2 mm) long sleeves with 9 inches (228.6 mm) into each pipe and held by two 3/8 inch (9.5 mm) hex bolts and lock nuts on each side of the joint. Grids shall be installed as indicated on the drawings with pipes intersecting on four foot by four-foot centers.
2. Intersecting pipes shall be joined with a Cross Grid Clamp or by an approved equal. The cross grid clamp shall have a recommended working load of at least 1,500 lbs (680 kg). U-bolts are not acceptable.
3. Each pipe shall terminate at the catwalk vertical supports in the black box and at the wall in the film studio space. Internally sleeved wall plates shall securely brace the grid against the wall once it is in place. Supply sufficient braces to prevent lateral movement of the pipe grid.
4. The grid shall be rigidly hung from the overhead steel structures on centers not exceeding 8 feet in either direction using 1/4 inch (6.4 mm), 7x19 galvanized utility cable ending in 6 inches x 3/8 inch (152.4 mm x 9.5 mm) forged turnbuckles attached to pipe clamps or connector strip hanging brackets. At each hanging point the cable shall attach to the overhead structure with an appropriate fitting. Cables shall be formed over thimbles of correct size and fastened with two forged cable clips or Nicopress sleeves. Turnbuckles shall be safetied with tie wire after final trim.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine installation areas and mounting surfaces with Installer present, for compliance with manufacturer's installation tolerances including required clearances, floor level, location of blocking and anchoring reinforcements, and other existing conditions that may affect installation or performance.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Proceed with installation only after correction of unsatisfactory conditions.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION - GENERAL

- A. Install manufactured units in accordance with manufacturer's recommendations, approved submittals, and in proper relationship with adjacent construction.

- B. Clean exposed surfaces. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

3.4 INSTALLATION OF RIGGING SYSTEMS

- A. Equipment shall be installed by fully trained superintendents and workmen. The Rigging Contractor shall employ Entertainment Technician Certification Program (ETCP) Certified theatre Riggers. Certified Riggers shall, at a minimum, be used as the project manager and site foreman and be responsible for the overall project including the layout, inspection, and onsite user training.
- B. Equipment shall be installed per plans and specifications. Equipment shall be aligned, adjusted, and trimmed for the most efficient operation, the greatest safety and for the best visual appearance.
- C. Standards: Installation practices shall be in accordance with OSHA Safety and Health Standards and all local codes. All welding shall be performed in full compliance with the latest edition of the Structural Welding Code (ANSI/AWS D1.1).
- D. Alignment: Mule blocks, cable rollers and guides shall be installed, as required, to provide proper alignment, to maintain specified fleet angles, and to prevent contact with other surfaces.
- E. Attachments: All equipment shall be securely attached to the building structure.

3.5 INSPECTION AND TESTING OF RIGGING SYSTEMS

- A. Inspection: During the installation of equipment the Rigging Contractor shall arrange for access as necessary for inspection of equipment by the Owner's representatives.
- B. System Pre-Testing By Rigging Contractor: On completion of installation the Rigging Contractor shall conduct a complete test of the system to ensure it is working properly and in conformance with this specification.
- C. Completion Testing: Upon completing the installation, the Rigging Contractor shall notify the Owner or Owner's Representative, who shall schedule inspection and testing of the full rigging system. At the time of testing, the Rigging Contractor shall furnish sufficient workers to operate all equipment and to perform such adjustments and tests as may be required by the Owner's representative. All testing equipment and personnel shall be at the Rigging Contractor's expense. Any equipment, which fails to meet with approval, shall be repaired or replaced with suitable equipment and the inspection shall be re-scheduled under the same conditions as previously specified. At the time of these inspections, no other work shall be performed in the auditorium and stage areas. All temporary bracing, scaffolding, etc. shall be removed to permit full operation of, and access to, all equipment. Final approval shall be withheld until all systems have been thoroughly tested and found to be in full working order and meets requirements herein.
 - 1. Manual counterweight rigging shall be tested in accordance with ANSI E1.4 "Entertainment Technology Manual Counterweight Rigging Systems".
 - 2. Powered rigging shall be tested. Each hoist shall be operated over five full continuous cycles at 1.25 times its full working load at full speed and travel distance. The emergency stop function shall be tested at 100 percent WLL in both the ascending and

descending directions.

- a. Demonstrate that all over travel limit switches have been correctly set for the actual field conditions of the specific project.
 - b. If it applies to the project, demonstrate that all position encoders have been correctly set for the actual field conditions of the specific project.
 3. Provide written recommendations to the Owner for necessary repairs or changes not included in the warranty. Provide a copy to the rigging equipment Manufacturer and in the Operations Manual.
- D. The Owner or Owner's Representative shall witness and sign off on the inspection. A copy of the certificate shall be included in the permanent log turned over to the owner.
- E. Upon completion of the work, the Rigging Contractor shall submit 3 copies of a comprehensive Operating and Maintenance Manual including as-built shop drawings, equipment descriptions, and parts lists. The Rigging Contractor shall provide a safety and instruction class with personnel designated by the owner to demonstrate and explain the operation and maintenance of the systems.
- F. Signage with basic operating instructions and warnings shall be posted in the area where the equipment shall be operated. Signage shall be in conformance with ANSI-Z535.

3.6 RIGGING SYSTEMS, FOLLOW-UP INSPECTION

- A. The Contractor shall return to site 12 months and 24 months after system turnover and provide the following services:
1. Inspection in accordance with ANSI E1.4-1 Entertainment Technology - Manual Counterweight Rigging Systems, ANSI E1.6-1 Entertainment Technology - Powered Hoist Systems, and ANSI E1.47 - Recommended Guidelines for Entertainment Rigging System Inspections.
 2. Make all required adjustments.
 3. Correct all warranty items and provide a written report to the Owner and Manufacturer.
 4. Provide written recommendations to the Owner and Manufacturer for necessary repairs or changes not included in the warranty.
 5. Conduct a rigging operation and safety class.
 6. Subsequent to the 24 month inspection, provide a written proposal for the following year's inspection.

3.7 FIELD QUALITY CONTROL

- A. Inspect installed work to verify compliance with requirements.
1. Verify that HVAC work and electrical work complies with manufacturer's submittals and written installation requirements.
 2. Perform installation and startup checks as recommended by manufacturer.
 3. Prepare inspection reports and submit to Architect.

3.8 DEMONSTRATION

- A. Train Owner's personnel to adjust, operate, and maintain equipment. Turn over keys, tools, and operation and maintenance instructions to Owner.

3.9 CLEANING AND PROTECTION

- A. Repair or replace defective work as directed by Architect upon inspection.
- B. Clean surfaces. Touch up marred finishes, or replace damaged components that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by manufacturer.
- C. Protect installed products from damage, abuse, dust, dirt, stain, or paint until completion of project. Do not permit use during construction.

END OF SECTION

SECTION 12 24 13
ROLLER WINDOW SHADES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manually operated sunshade roller shades with single rollers.
 - 2. Motor-operated sunshade roller shades with single rollers.
 - 3. Motor-operated sunshade and blackout roller shades with dual rollers.
 - 4. Closure Trims.
 - 5. Shade Pockets.
- B. Related Requirements:
 - 1. Section 06 10 00 "Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
 - 2. Section 07 92 00 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.
 - 3. Section 09 29 00 "Gypsum Board" for coordination with gypsum board assemblies for installation of closure and related accessories.
 - 4. Division 26 Sections for electrical service and connections for motors, controls, limit switches, and other powered devices and for system disconnect switches for motor-operated shades.
 - 5. Roller Shade work includes the following:
 - a. Roller shade hardware, shade fabric, and motor furnished and installed as a complete assembly.
 - b. All electrical and electronic controls and accessories required for a complete control system including appropriate interface to communicate with stand alone BAS, daylighting or AV systems.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
- B. Sustainable Design Submittals:
 - a. Materials, products and procedures within this Section shall contribute to the Project's sustainable design goals, including those defined by the USGBC's LEED Version 4 and/or Version 4.1 for Building Design and Construction Rating System. Refer to Section 01 81 13.14 (Sustainable Design Requirements) for the project's target certification level and specific certification requirements. The Contractor shall ensure that the requirements related to the project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work related to this section proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification target.
- C. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
 - 1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.

- D. Samples: For each exposed product and for each color and texture specified, 10 inches long.
- E. Samples for Initial Selection: For each type and color of shadeband material.
 - 1. Include Samples of accessories involving color selection.
- F. Samples for Verification: For each type of roller shade.
 - 1. Shadeband Material: Not less than 10 inches square. Mark interior face of material if applicable.
 - 2. Roller Shade: Full-size operating unit, not less than 16 inches wide by 36 inches long for each type of roller shade indicated.
 - 3. Installation Accessories: Full-size unit, not less than 10 inches long.
- G. Product Schedule: For roller shades. Install manual or motorized Roller Shades as noted on drawings.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of shadeband material.
- C. Product Test Reports: For each type of shadeband material, for tests performed by a qualified testing agency.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Obtain roller shades system through one source from a single manufacturer with a minimum of ten years of experience and minimum of five projects of similar scope and size in manufacturing products comparable to those specified in this section.
- B. Installer Qualifications: Installer trained and certified by the manufacturer with a minimum of ten years of experience in installing products comparable to those specified in this section.
- C. Turn-Key Single-Source Responsibility for Wiring Motorized Interior Roller Shades: To control the responsibility for performance of motorized roller shade systems, assign the design, engineering, and installation of motorized roller shade systems, motors, controls, and low voltage electrical control wiring specified in this Section to a single manufacturer and their authorized installer/dealer. Coordinate the following with the roller shade installer/dealer:
 - 1. Contractor shall coordinate with requirements of roller shade installer/dealer, before inaccessible areas are constructed.
 - 2. Roller shade installer/dealer shall provide and run all low voltage wiring as dedicated home runs terminating at shade multi-motor power panels in locations designated by roller shade dealer, architect, and electrical engineer.
 - 3. Roller shade installer/dealer shall provide and run all low voltage wiring to the motor controllers, wire all roller shade motors to the motor controllers, and provide and run low voltage control wiring from motor controllers to switch/ control locations designated by the Architect. All above-ceiling and concealed wiring shall be plenum-rated, or installed in conduit, as required by the electrical code having jurisdiction.
 - 4. Electrical Contractor shall provide conduit with pull wire in all areas, which might not be accessible to roller shade contractor due to building design, equipment location or schedule, or as designated on the drawings.
 - 5. Electrical Contractor shall provide dedicated 20A circuits and dedicated receptacles for power to shade multi-motor power panels in locations designated by roller shade dealer, architect, and electrical engineer.

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

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.8 WARRANTY

- A. Roller Shade Hardware and Chain Warranty: Manufacturer's standard non-depreciating warranty for interior shading.
 - 1. Shade Hardware: 25 years.
 - 2. Standard Shadecloth: Manufacturer's standard 25 year warranty.
 - 3. Roller Shade Motors, Motor Control Systems, and Accessories: Manufacturer's standard non-depreciating 5 year warranty.

1.9 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Current Edition, Including All Revisions.
- C. WCMA A100.1 - Standard for Safety of Window Covering Products; 2022.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Basis of Design: Mecho/5x System as manufactured by MechoShade Systems LLC.
 - 1. Description: Manually operated window shades.
 - a. Shade Type: Single Roller.
 - b. Drop Position: Regular roll.

- c. Mounting: As indicated on drawings.
 - d. Size: Lengths, to work with mullion spacing to provide full shade coverage of a room, Typical.
- 2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
 - a. Material: Steel, 1/8 inch thick.
- B. Clutch Operator: Manufacturer's standard material and design integrated with bracket/brake assembly.
 - 1. Permanently lubricated brake assembly mounted on an oil-impregnated hub with wrapped spring clutch.
 - 2. Brake must withstand minimum pull force of 50 pounds in the stopped position.
 - 3. Mount clutch/brake assembly on the support brackets, fully independent of the roller tube components.
- C. Drive Chain: Continuous loop stainless steel beaded ball chain, 95 pound minimum breaking strength. Provide upper and lower limit stops.
 - 1. Chain Retainer: Chain tensioning device complying with WCMA A100.1
- D. Rollers: Extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with assemblies designed to facilitate removal of shadebands for service.
 - 1. Roller Drive-End Location: Left side of inside face of shade.
 - 2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
 - 3. Shadeband-to-Roller Attachment: Removable spline fitting into integral channel in tube.
- E. Shadebands:
 - 1. Shadeband Material: As indicated in Section 2.4 Shadeband Materials.
 - 2. Shadeband Bottom (Hem) Bar Style: Full wrap fabric covered bottom bar, flat profile with heat sealed closed ends.

2.3 24V DC MOTOR-OPERATED, SINGLE-ROLLER & DUAL SHADES

- A. Basis of Design: ElectroShade with WhisperShade IQ2 24v 4NM DC EDU. As manufactured by MechoShade Systems LLC.
 - 1. Description: Motor operated window shades.
 - a. Motorized Shades to comply with NFPA 70.
 - b. Electric Motor: Whispershade IQ2 24v DC tubular motor, enclosed in roller.
 - c. Electrical Characteristics: 24v DC, 4NM, quiet operation.
 - d. Shade Type: Single and Double Rollers.
 - e. Drop Position: Regular roll.
 - f. Mounting: As indicated on drawings.
 - g. Size: As indicated on drawings.
- B. Electronic Drive Unit (EDU) System General Requirements:
 - 1. A UL 325 listed solution.
 - a. Component certification in lieu of system testing is not acceptable.
 - b. Size and Configuration: As recommended by manufacturer for type, size, and arrangement of shades.
 - 2. Conceal EDU inside shade roller tube.
- C. Low Voltage EDU (24 VDC):

1. Basis of Design: MechoShade Systems LLC; WhisperShade IQ2-DC System. Tubular, asynchronous, integral DC motor. 24 VDC; temperature Class B, thermally-protected, totally enclosed, maintenance-free. Powered by low voltage power supply connection equipped with disconnect plug assembly furnished with EDU.
2. Audible Noise: 38 dBA measured 3 ft from motor unit, depending on motor torque.
3. Nominal Speed: 10 to 28 RPM. Configurable. Speed managed such that it does not vary due to load/lift capacity.
4. 10-Motor Power Panel: Whispershade IQ2-DC Power Panel Specifications.
 - a. Power Input: 100 – 240 VAC, 50 - 60Hz, 5.9A at 115 VAC / 2.65A at 230 VAC.
 - b. Power Output: 24 VDC +2.6/-1.0 VDC, 21 A, (10 motor power supply connections individually fused at 2.5A).
5. Low voltage power supply for powering external accessories connected to either the dry contact or network port.
 - a. Products that require accessories to be powered by a plug-in or externally-supplied power supply are not acceptable.
- D. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
 1. Material: Steel, 1/8 inch thick.
 2. Multiple Shade Operation: Provide hardware as necessary to operate more than one shade using a single motor.
- E. Rollers: Extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with assemblies designed to facilitate removal of shadebands for service.
 1. Roller Drive-End Location: As indicated on drawings.
 2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
 3. Shadeband-to-Roller Attachment: Removable spline fitting into integral channel in tube.
- F. Shadebands:
 1. Shadeband Material: As indicated in Section 2.4 Shadeband Materials.
 2. Shadeband Bottom (Hem) Bar Style: Full wrap fabric covered bottom bar, flat profile with heat sealed closed ends.
- G. Control Methods: Local isolated dry contact input and network control:
 1. Local Isolated Dry Contact Inputs:
 - a. Local switch control, third party system integration without separate interface.
 - b. Moving EDU/shade to upper and lower limits and local switch preset positions.
 2. Network Control:
 - a. Bi-directional network communication to enable commanding operation of large groups of shades over a common backbone.
- H. Motor Controls, Interfaces, and Accessories:
 1. Unless indicated to be excluded, provide required equipment as necessary for a complete operating system providing the control intent specified. Provide components and connections necessary to interface with other systems as indicated.
 2. Network Interface Components:
 - a. Integrated MechoNet Network Interface; configurable switch ports; configurable serial port for RS232 communication.

3. Low-Voltage Wall Controls; IQ Switch:
 - a. Momentary dry contact switch enables manual local control or network control of any individual shade motor or shade group/sub-group on MechoNet network.
 - b. Control functions for Open, Close, and Presets for selection of predetermined shade positions.

2.4 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
 1. Source: Mechoshade Thermoveil 1300 fabric.
 2. Weave: Basketweave.
 3. Orientation on Shadeband: As indicated on approved Shop Drawings.
 4. Openness Factor: 5 percent.
 5. Color: Grey 1313
- C. Light-Blocking Fabric: Opaque fabric, stain and fade resistant.
 1. Source: Light-blocking fabric, Room darkening (PVC Free) Shadecloth with opaque acrylic backing: MechoShade Systems, Inc., "Equinox 0100 series"
 2. Type: comprising of 53% fiberglass, 45% acrylic, 2% poly finish.
 3. Thickness: .008 inches thick (.19 mm) blackout material
 4. Weight: 15.1 oz./sq. yd.
 5. Roll Width: MechoShade stocks in 100 inches.
 6. Orientation on Shadeband: As indicated on approved Shop Drawings
 7. Color: As selected by Architect from manufacturer's full range.

2.5 ROLLER SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
 1. Between (Inside) Jamb Installation: As indicated on drawings. Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch (6 mm), plus or minus 1/8 inch.
 2. Outside of Jamb Installation: As indicated on drawings. Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:
 1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.
 2. Skylight Shades: Provide battens and seams at uniform spacings along shadeband as required to ensure shadeband tracking and alignment through its full range of movement without distortion or sag of material.

3. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

2.6 SHADE POCKET

- A. Roller Shade Pocket: Basis of Design - as manufactured by Mecho, or equal.
 1. Premanufactured continuous 2-piece Closure Trim: Aluminum extrusion that conceals underside of roller and operating mechanism. Provide Built-in "No Cost Pocket" trim with removable "3 inch Closure " and "Closure Mount". Anchor "Closure Mount" to stud framing or other suitable substrate. Bottom of removable closure to align with bottom of adjacent GWB.
 - a. Location: See Drawings.
 - b. Color and Finish: White.
 2. Model: Standard Pocket Model 4155 installed below ceiling with removable closure.
 - a. Material: Extruded Aluminum.
 - b. Color: White.
 - c. Location: In the Multi-purpose room.
 3. Endcap Covers: To cover exposed endcaps.
 4. Installation Accessories Color and Finish: As selected from manufacturer's full range.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, locations of connections to building electrical system, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
 1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.
- B. Electrical Connections: Connect motor-operated roller shades to building electrical system.
- C. Roller Shade Locations: As indicated on Drawings.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION 12 24 13

SECTION 14 24 00
HYDRAULIC ELEVATORS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Complete hydraulic elevator systems.
 - 1. New Hydraulic Passenger type.
 - 2. Renovation to existing elevator (see report attached, for 75% CD review. Final specification will be incorporated in this section prior to 100% CD).
- B. Elevator Maintenance Contract.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Includes elevator pit and inserts and anchoring devices in concrete.
- B. Section 04 20 00 - Unit Masonry: Masonry hoistway enclosure; building-in and grouting hoistway door frames.
- C. Section 05 12 00 - Structural Steel Framing: Includes hoistway framing, divider beams, overhead hoist beams, and ____.
- D. Section 05 50 00 - Metal Fabrications: Includes elevator pit ladder, sill supports, divider beams, overhead hoist beams, and ____.
- E. Section 07 14 16 Cold Fluid-Applied Waterproofing: Waterproofing of elevator pit walls and floor.
- F. Section 09 65 00 - Resilient Flooring: Floor finish in car.
- G. Section 09 68 16 - Sheet Carpeting: Floor finish in car.
- H. Section 09 91 23 - Interior Painting: Field painting of hoistway entrance doors and frames.
- I. Section 21 13 00 - Fire-Suppression Sprinkler Systems: Sprinkler heads in hoistway.
- J. Section 22 05 13 - Common Motor Requirements for Plumbing Equipment: Motor for sump pump in pit.
- K. Section 26 05 33.13 - Conduit for Electrical Systems:
 - 1. Conduit to elevator equipment devices remote from elevator machine room, hoistway, or ____.
- L. Section 26 05 83 - Wiring Connections:
 - 1. Electrical characteristics and wiring connections.
 - 2. Electrical service to main disconnect located in elevator machine room.
 - 3. Emergency power transfer cabinet.
 - 4. Electrical power for elevator installation and testing.
 - 5. Electrical disconnecting device to elevator equipment prior to activation of sprinkler system.
 - 6. Electrical service for machine room, convenience outlets, elevator pit, and ____.
 - 7. Lighting in elevator pit.
 - 8. Conduit for telephone service to location(s) as indicated on drawings.
- M. Section 26 36 00 - Transfer Switches: For interface with elevator controls.
- N. Section 28 20 00 - Video Surveillance: Installation of video camera in car interior for security monitoring.
- O. Section 28 46 00 - Fire Detection and Alarm:
 - 1. Fire and smoke detectors and interconnecting devices.
 - 2. Fire alarm signal lines to elevator controller cabinet.

1.3 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.
- B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- C. AISC 360 - Specification for Structural Steel Buildings; 2022.
- D. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test; 2015 (Reaffirmed 2020).
- 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. ASME A17.1 - Safety Code for Elevators and Escalators Includes Requirements for Elevators, Escalators, Dumbwaiters, Moving Walks, Material Lifts, and Dumbwaiters with Automatic Transfer Devices; 2022.
- G. ASME A17.2 - Guide for Inspection of Elevators, Escalators, and Moving Walks Includes Inspection Procedures for Electric Traction and Winding Drum Elevators, Hydraulic Elevators, Inclined Elevators, Limited-Use/Limited-Application Elevators, Private Residence Elevators, Escalators, Moving Walks, Dumbwaiters, and Material Lifts; 2023.
- H. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- I. ASTM A139/A139M - Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over); 2022.
- J. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2024.
- K. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- L. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.
- M. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2023, with Editorial Revision.
- N. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- O. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- P. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- Q. ASTM B455/B455M - Standard Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Extruded Shapes; 2020.
- R. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2018.
- S. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
- T. ITS (DIR) - Directory of Listed Products; Current Edition.
- U. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- V. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- W. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.
- X. UL (DIR) - Online Certifications Directory; Current Edition.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate work with other installers to provide conduits necessary for installation of wiring including but not limited to:
 - a. Elevator equipment devices remote from elevator machine room or hoistway.

- b. Remote group automatic panel in lobby from controller cabinet.
 - c. Telephone service for machine room.
 - d. Elevator pit for lighting, sump pump, and ____.
 - e. Automatic transfer switch from controller cabinet.
 - f. Fire alarm panel from controller cabinet.
- 2. Coordinate work with other installers for equipment provisions necessary for proper elevator operation, including but not limited to, the following:
 - a. Automatic transfer switches with auxiliary contacts for emergency power transfer status indication.
 - b. Shunt trip devices for automatic disconnection of elevator power prior to fire suppression system activation.
 - c. Overcurrent protection devices selected to achieve required selective coordination.
- B. Preinstallation Meeting: Convene meeting at least one week prior to start of this work.
 - 1. Review schedule of installation, proper procedures and conditions, and coordination with related work.
- C. Construction Use of Elevator: Not permitted.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit data on following items:
 - 1. Signal and operating fixtures, operating panels, and indicators.
 - 2. Car design, dimensions, layout, and components.
 - 3. Car and hoistway door and frame details.
 - 4. Electrical characteristics and connection requirements.
- C. Shop Drawings: Include appropriate plans, elevations, sections, diagrams, and details on following items:
 - 1. Elevator Equipment and Machines: Size and location of driving machines, power units, controllers, governors, and other components.
 - 2. Hoistway Components: Size and location of car guide rails, buffers, jack unit and other components.
 - 3. Rail bracket spacing; maximum loads imposed on guide rails requiring load transfer to building structural framing.
 - 4. Individual weight of principal components; load reaction at points of support.
 - 5. Clearances and over-travel of car.
 - 6. Locations in hoistway and machine room of traveling cables and connections for car lighting, telephone, and ____.
 - 7. Location and sizes of hoistway and car doors and frames.
 - 8. Calculated heat dissipation of elevator equipment in machine room.
 - 9. Applicable seismic design data; certified by a licensed Professional Structural Engineer.
 - 10. Interface with building security system.
 - 11. Electrical characteristics and connection requirements.
 - 12. Indicate arrangement of elevator equipment and allow for clear passage of equipment through access openings.
- D. Samples: Submit samples illustrating car interior finishes, car and hoistway door and frame finishes, handrail material and finish, and signal equipment finishes in the form of 3 inch square samples of sheet material; and 4 inches length of running trim members.

- E. Cut sheets: Include cut sheets of all fixtures, and all lighting, including luminaries, lamps and ballast controls.
- F. Designer's Qualification Statement.
- G. Manufacturer's Qualification Statement.
- H. Installer's Qualification Statement.
- I. Testing Agency's Qualification Statement.
- J. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- K. Initial Maintenance Contract.
- L. Maintenance Contract: Submit proposal to Owner for standard one year continuing maintenance contract agreement in accordance with ASME A17.1 and requirements as indicated, starting on date initial maintenance contract is scheduled to expire.
 - 1. Indicate in proposal the services, obligations, conditions, and terms for agreement period and for renewal options.
- M. Operation and Maintenance Data:
 - 1. Parts catalog with complete list of equipment replacement parts; identify each entry with equipment description and identifying code.
 - 2. Operation and maintenance manual.
 - 3. Schematic drawings of equipment and hydraulic piping, and wiring diagrams of installed electrical equipment with list of corresponding symbols to identify markings on machine room and hoistway apparatus.

1.6 QUALITY ASSURANCE

- A. Designer Qualifications: Design guide rails, brackets, anchors, and machine anchors under direct supervision of a licensed Professional Structural Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and approved by elevator equipment manufacturer.
- D. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of type specified in this section.
- E. Products Requiring Fire Resistance Rating: Listed and classified by ITS (DIR), UL (DIR), or testing agency acceptable to authorities having jurisdiction.
- F. Products Requiring Electrical Connection: Listed and classified by UL (DIR) or testing agency acceptable to authorities having jurisdiction as suitable for the purpose indicated in construction documents.

1.7 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's warranty for elevator operating equipment and devices for one year from Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Hydraulic Elevator Manufacturers:

1. Basis-of-Design Product: Provide Endura hydraulic low-rise, above-ground jack with machine room as manufactured by TK Elevator: www.tkelevator.com/#sle, or comparable product of other manufacturers approved by the Architect.
- B. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Source Limitations: Provide elevator and associated equipment and components produced by the same manufacturer as the other elevator equipment used for this project and obtained from a single supplier.

2.2 HYDRAULIC ELEVATORS

- A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturer's standard components shall be used, as included in standard elevator systems and as required for complete system.
- B. Hydraulic Passenger Elevator:
 1. Hydraulic Elevator Equipment:
 - a. Holeless hydraulic with cylinder mounted within hoistway.
 2. Drive System:
 - a. Variable voltage variable frequency (VVVF) to modulate motor speed.
 3. Operation Control Type:
 - a. Selective Collective Automatic Operation Control.
 4. Service Control Type:
 - a. Standard service control only.
 5. Interior Car Height: 7'-4".
 6. Electrical Power: 480 volts; alternating current (AC); three phase; 60 Hz.
 7. Rated Net Capacity: 3500 pounds.
 8. Rated Speed: 100 feet per minute.
 9. Hoistway Size: 8'-4" inch wide by 6'-11" inch deep.
 10. Interior Car Platform Size: 6'-8" inch wide by 5'-5" inch deep.
 11. Elevator Pit Depth: 60 inch, confirm with the selected elevator manufacturer.
 12. Overhead Clearance at Top Floor: 152 inch.
 13. Travel Distance: As indicated on drawings.
 14. Number of Stops: Two.
 15. Number of Openings: Two Front.
 16. Hydraulic Equipment Location: Adjacent to top of elevator hoistway shaft, see drawings

2.3 COMPONENTS

2.4 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with ASME A17.1, applicable local codes, and authorities having jurisdiction (AHJ).
- B. Accessibility Requirements: Comply with ADA Standards.
- C. Perform structural steel design, fabrication, and installation in accordance with AISC 360.
- D. Comply with seismic design requirements in accordance with ASME A17.1, applicable local codes, authorities having jurisdiction (AHJ), and ____.
 1. Complying with Elevator Safety Requirements for Seismic Risk Zone in accordance with ASME A17.1, ASCE 7 and other related requirements.
 - a. Project Seismic Risk: As indicated on drawings.

2. Provide earthquake emergency operations in accordance with ASME A17.1 requirements.
- E. Perform welding of steel in accordance with AWS D1.1/D1.1M.
- F. Fabricate and install door and frame assemblies in accordance with NFPA 80 and in compliance with requirements of authorities having jurisdiction.
- G. Perform electrical work in accordance with NFPA 70.
- H. Comply with venting or pressurization of hoistway design in accordance with HVAC system requirements and authorities having jurisdiction (AHJ).
- I. Comply with fire protection sprinkler system of hoistway design in accordance with NFPA 13 requirements and authorities having jurisdiction (AHJ). See Section 21 13 00.

2.5 OPERATION CONTROLS

- A. Elevator Controls: Provide landing operating panels and landing indicator panels.
 1. Landing Operating Panels: Metallic type, one for originating "Up" and one for originating "Down" calls, one button only at terminating landings; with illuminating indicators.
 2. Landing Indicator Panels: Illuminating.
 3. Comply with ADA Standards for elevator controls.
- B. Interconnect elevator control system with building security, fire alarm, card access, smoke alarm, and building management control systems.
- C. Door Operation Controls:
 1. Program door control to open doors automatically when car arrives at floor landing.
 2. Render "Door Close" button inoperative when car is standing at dispatch landing with doors open.
 3. Door Safety Devices: Moveable, retractable safety edges, quiet in operation; equipped with photo-electric light rays.
- D. Lobby Monitoring Panel:
 1. Locate status indicator and control panel for each individual elevator and group of elevators as indicated on drawings.
 2. Etch face plate markings in panel, and fill with paint of contrasting color.
 3. Include direction indicator displaying landing "Up" and "Down" calls registered at each landing floor.
 4. Include position and motion display for direction of travel of each elevator. Display appropriate graphic characters on non-glare screen. Indicate position of cars at rest and in motion.
 5. Include a "Remove From In Service" switch for each elevator that then calls car to ground floor and parks car with doors open.
 6. Include emergency power selector switch for each group of elevators that overrides automatic emergency power selection.
 7. Include "Firefighter's Service Switch" that manually recalls each elevator to main floor.
- E. Provide "Firefighter's Emergency Operation" in accordance with ASME A17.1, applicable building codes, authorities having jurisdiction (AHJ), and ____.
 1. Designated Landing: At first floor.

2.6 OPERATION CONTROL TYPE

- A. Single Automatic (Push Button) Operation Control: Applies to car in single elevator shaft.
 1. Refer to description provided in ASME A17.1.
 2. Set system operation so that momentary pressure of landing button dispatches car from other landing to that landing.

3. Allow call registered by momentary pressure of landing button at any time to remain registered until car stops in response to that landing call.
4. If elevator car door is not opened within predetermined period of time after car has stopped at terminal landing allow car to respond to call registered from other landing.
- B. Selective Collective Automatic Operation Control: Applies to car in single elevator shaft.
 1. Refer to description provided in ASME A17.1.
 2. Automatic operation by means of one button in the car for each landing served and by "UP" and "DOWN" buttons at the landings.
 3. Stops are registered by momentary actuation of landing car buttons without consideration of the number of buttons actuated or the sequence buttons are actuated, but the stops are made in the order that landings are reached in each direction of travel.
 4. All "UP" landing calls are made when car is traveling in the up direction.
 5. All "DOWN" landing calls are made when car is traveling in the down direction.
 6. Uppermost and lowermost calls are answered as soon as they are reached without consideration of the car travel direction.

2.7 EMERGENCY POWER

- A. Set-up elevator operation to run with elevator emergency power supply when the normal building power supply fails, and in compliance with ASME A17.1 requirements.
- B. Elevator Emergency Power Supply: Supplied by battery backup; provide elevator system components as required for emergency power characteristics.
- C. Emergency Lighting: Comply with ASME A17.1 elevator lighting requirements.
- D. Provide operational control circuitry for adapting the change from normal to emergency power.
- E. Upon transfer to emergency power, advance one elevator at a time to a pre-selected landing, stop car, open doors, disable operating circuits, and hold in standby condition.

2.8 MATERIALS

- A. Steel Cylinder Casing: ASTM A139/A139M, Grade A steel.
- B. Rolled Steel Sections, Shapes, Rods: ASTM A36/A36M.
- C. Steel Sheet: ASTM A1008/A1008M, Designation CS (commercial steel), with matte finish.
- D. Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.
- E. Stainless Steel Sheet: ASTM A666, Type 304; No. 4 Brushed finish unless otherwise indicated.
- F. Stainless Steel Bars, Shapes and Moldings: ASTM A276/A276M, Type 304.
- G. Extruded Brass Shapes: ASTM B455/B455M, Copper Alloy UNS C38500, Architectural Bronze, 57 percent copper, polished finish.
- H. Extruded Aluminum: ASTM B221 (ASTM B221M), natural anodized finish unless otherwise indicated.
- I. Aluminum Sheet: ASTM B209/B209M, 3105 alloy, O temper.
- J. Tempered Glass: 3/8 inch minimum thickness, fully tempered in compliance with ASME A17.1, 16 CFR 1201, ANSI Z97.1, and ASTM C1048 tempered glass requirements.
- K. Resilient Flooring: Vinyl tile flooring and Resilient flooring, see Section 09 65 00, Type ____.
- L. Carpet Flooring: See Section 09 68 16.

2.9 CAR AND HOISTWAY ENTRANCES

- A. Elevator, Art Annex:
 1. Car and Hoistway Entrances:
 - a. Hoistway Fire Rating: 1 Hour.

- b. Elevator Door Fire Rating: 1 Hour.
- c. Framed Opening Finish and Material: Brushed stainless steel.
- d. Car Door Material: Stainless steel, with rigid sandwich panel construction.
- e. Hoistway Door Material: Stainless steel, with rigid sandwich panel construction.
- f. Door Type: Single leaf.
- g. Door Operation: Side opening, two speed.
- h. Door Width: 42 inches.
- i. Door Height: 84 inches.
- j. Sills: Extruded aluminum.

2.10 CAR EQUIPMENT AND MATERIALS

A. Elevator Car, Art Annex:

- 1. Car Operating Panel: Provide main and auxiliary; flush-mounted applied face plate, with illuminated call buttons corresponding to floors served with "Door Open/Door Close" buttons.
 - a. Panel Material: Integral with front return; one per car.
 - b. Car Floor Position Indicator: Above door with illuminating position indicators.
 - c. Locate alarm button where it is unlikely to be accidentally actuated; not more than 54 inch above car finished floor.
- 2. Ventilation: Single speed fan with grille in ceiling.
- 3. Flooring: Resilient tile.
- 4. Front Return Panel: Match material of car door.
- 5. Door Wall: Rigidized stainless steel, min. of 16 gauge panels..
- 6. Side Walls: Rigidized stainless steel, min. of 16 gauge panels..
- 7. Rear Wall: Rigidized stainless steel, min. of 16 gauge panels..
- 8. Hand Rail: Stainless steel, at all three sides. Provide open clearance space 1-1/2 inch (38 mm) wide to face of wall.
 - a. Flat Bar Stock, Solid: 2 inch high.
 - b. Stainless Steel Finish: No. 4 Brushed.
- 9. Ceiling:
 - a. Suspended: White translucent diffusers with ceiling frames.

B. Car Accessories:

- 1. Certificate Frame: Stainless steel frame glazed with tempered glass, and attached with tamper-proof screws.
- 2. Protective Pads: Heavy-Duty cover, padded with impact-resistant fill material, sewn with piping edges; fire resistant in compliance with ASME A17.1; brass grommets for supports, covering side and rear walls and front return, with cut-out for control panel; provide one set for each elevator.
 - a. Color: Grey.
 - b. Provide at least 4 inch clearance from bottom of pad to finished floor.
 - c. Pad Supports: Stainless steel studs, and mounted from ceiling frame.

2.11 MACHINE ROOM FITTINGS

- A. Wall-Mounted Frames: Glazed with clear plastic; sized as required. Provide one chart each for master electric and hydraulic schematic and for lubrication chart. Install charts.

- B. Key Cabinet: Wall-mounted, lockable, keyed to building keying system, for control and operating panel keys.
 - 1. Provide two key cabinet keys.
 - 2. Provide two control/operating panel keys.
 - 3. Provide two card access keys.
- C. Monitoring Device Interface:
 - 1. Fabricate one multiple terminal block in controller relay panel or selector, in location indicated, for connection of monitoring devices for:
 - a. Landing and car registration circuits.
 - b. Motor generator running circuits.
 - c. Load weighing circuits.
 - d. Up and down peak programming circuits.
 - e. Independent service switches.

2.12 FINISHES

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting this work.
- B. Verify that hoistway, pit, machine room, and ____ are ready for work of this section.
- C. Verify hoistway shaft and openings are of correct size and within tolerance.
- D. Verify location and size of machine foundation and position of machine foundation bolts.
- E. Verify that electrical power is available and of correct characteristics.

3.2 PREPARATION

- A. Arrange for temporary electrical power for installation work and testing of elevator components; see Section 01 50 00 - Temporary Facilities and Controls for additional requirements.
- B. Maintain elevator pit excavation free of water.

3.3 INSTALLATION

- A. Coordinate this work with installation of hoistway wall construction.
- B. Install system components, and connect equipment to building utilities.
- C. Provide conduit, electrical boxes, wiring, and accessories; see Sections 26 05 33.13 and 26 05 83.
- D. Install hydraulic piping between cylinder and pump unit.
- E. Mount machines, motors, pumps, and ____ on vibration and acoustic isolators.
 - 1. Place on structural supports and bearing plates.
 - 2. Securely fasten to building supports.
 - 3. Prevent lateral displacement.
- F. Install hoistway, elevator equipment, and components in accordance with approved shop drawings.
- G. Install guide rails to allow for thermal expansion and contraction movement of guide rails.
- H. Accurately machine and align guide rails, forming smooth joints with machined splice plates.
- I. Install hoistway door sills, frames, and headers in hoistway walls; grout sills in place, set hoistway floor entrances in alignment with car openings, and align plumb with hoistway.
- J. Fill hoistway door frames solid with grout; see Section 04 20 00.

- K. Structural Metal Surfaces: Clean surfaces of rust, oil or grease; wipe clean with solvent; prime two coats.
- L. Wood Surfaces not Exposed to Public View: Finish with one coat primer; one coat enamel.
- M. Adjust equipment for smooth and quiet operation.

3.4 TOLERANCES

- A. Guide Rail Alignment: Plumb and parallel to each other in accordance with ASME A17.1 and ASME A17.2.
- B. Car Movement on Aligned Guide Rails: Smooth movement, without any objectionable lateral or oscillating movement or vibration.

3.5 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Testing and inspection by regulatory agencies certified in accordance with ASME QEI 1 will be performed at their discretion.
 - 1. Schedule tests with agencies and notify Owner and Architect.
 - 2. Obtain permits as required to perform tests.
 - 3. Document regulatory agency tests and inspections in accordance with requirements.
 - 4. Perform tests required by regulatory agencies.
 - 5. Furnish test and approval certificates issued by authorities having jurisdiction.
- C. Operational Tests:
 - 1. Perform operational tests in the presence of Owner and Architect.
 - 2. Test single elevator system by transporting at least ____ persons up from main floor to top floor landings during a five minute period.
 - 3. At an agreed time, and the building occupied with normal building traffic, conduct tests to verify performance.
 - a. Furnish event recording of each landing call registrations, time initiated, and response time throughout entire working day.
 - 4. Set period of time elevator takes to travel between typical floor landings at not more than ____ seconds.
 - a. Measure time from moment doors start to close until car has stopped level at next floor landing and doors are opening.

3.6 ADJUSTING

- A. Adjust for smooth acceleration and deceleration of car to minimize passenger discomfort.
- B. Adjust with automatic floor leveling feature at each floor landing to reach 1/4 inch maximum from flush with sill.

3.7 CLEANING

- A. Remove protective coverings from finished surfaces.
- B. Clean surfaces and components in accordance with manufacturers written instructions.

3.8 CLOSEOUT ACTIVITIES

- A. Demonstrate proper operation of equipment to Owner's designated representative.
- B. Training: Train Owner's personnel on cleaning and operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.

3. Instructor: Manufacturer's training personnel.
4. Location: At project site, unless noted otherwise.

3.9 PROTECTION

- A. Do not permit construction traffic within car after cleaning.
- B. Protect installed products until Date of Substantial Completion.
- C. Touch-up, repair, or replace damaged products and materials prior to Date of Substantial Completion.

3.10 MAINTENANCE

- A. Provide Initial Maintenance Contract of elevator system and components in accordance with ASME A17.1 and requirements as indicated for 3 months from Date of Substantial Completion.
- B. Perform maintenance contract services using competent and qualified personnel under the supervision and direct employ of the elevator manufacturer or original installer.
- C. Include systematic examination, adjustment, and lubrication of elevator equipment.
- D. Perform work without removing cars from use during peak traffic periods.

END OF SECTION 14 24 00

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DESIGN DEVELOPMENT REPORT

Renovation to Elevator No. 16
at

Craig Hall
Missouri State University



Prepared For:

DAKE | WELLS
architecture

Prepared By:



600 Emerson Rd., Suite 225
Creve Coeur, Missouri 63141
Phone: (636) 861-2722

February 2, 2024



February 2, 2024

Dake Wells Architecture
134 Park Central Square, Suite 300
Springfield, Missouri 65806

Attention: Renee Sutterer, AIA
Project Manager

Re: MSU Craig Hall
Springfield, Missouri
Elevator No. 16 Design Development Report

Ms. Sutterer:

Our firm was retained to make a physical inspection and written evaluation of the existing one (1) hydraulic Elevator No. 16 at Craig Hall on the Missouri State University – Springfield campus. The elevator was reviewed to assess the general condition of the equipment in addition to determine the level of elevator work necessary to substantially renovate it and provide for a minimum 25 years of additional service life. Any renovation recommendations shall consider compliance with the applicable alteration requirements of the 2016 ASME A17.1 Safety Code for Elevators and Escalators, State of Missouri Elevator Safety Act, the applicable portion of International Building Code (and applicable referenced NFPA codes), the ANSI A117.1 Accessibility and Usability of Disabled Persons, and the Department of Justice Americans with Disabilities Act (ADA), collectively referred to as “Accessibility”.

Executive Summary

Elevator No. 16 was originally manufactured and installed by Dover Elevator (currently TK Elevator) in approximately 1967 with the construction of the building. The elevator was modernized by Springfield Elevator Co. in approximately 1985 and was provided with new controls within the existing Dover controller, along with new fixtures, door equipment, and some other minor upgrades. This elevator is driven via a hydraulic power unit with direct (in-ground) plunger and cylinder (jack assembly), which was provided new in approximately 2007. Elevator No. 16 has a capacity of 2,000 lbs. and a contract speed of 125 fpm. There was a discrepancy with the state operating certificate indicating a speed of 100 fpm, but the top of car data tag shows 125 fpm, which is likely correct and will be what this report is based on. The elevator serves three (3) front landings at Floors ★1, 2, and 3, with a total travel of approximately 27'-2".

The elevator is in fair condition for its age, but the few remaining original components (hydraulic pumping unit, car structure, elevator cab, guide rails, etc.) are nearing 60 years old, and some upgraded components (elevator controller, fixtures, door equipment) are nearing 40 years old. MSU's elevator mechanic indicated that this elevator has been increasingly problematic in recent years due to issues with the hoistway door equipment and elevator controls. The primary liability of the elevator is the Virginia Controls relay logic controller. The relays may be replaceable for some time, but support for this controller will continue to dwindle. Fewer and fewer elevator mechanics are comfortable working on the older relay-logic controllers. It is the Consultant's understanding that MSU is ready to move forward with the renovation process in conjunction with modifications to the building. A renovation should provide a minimum of 25 years reliable service for the elevator and re-start the clock on obsolescence issues. Below, our firm has reviewed the

major components of the elevator system and provided recommendations that would be part of a renovation.

Review of Elevator Components

CONTROLLER - The existing controller and selector equipment consists of the upgraded Virginia Controls equipment from the 1985 modernization, although there is an oddity that the upgraded control equipment was provided in the original Dover controller housing, and some of the original components still remain. The controller consists of primarily relay components, though there are a couple of circuit boards present. The controller does have a form of fireman's emergency service operation and Accessibility operation, however, does not fully meet present day code.



The Existing Virginia Controls in the Original Dover Housing

A renovation would include replacement with new microprocessor controller, including the hoistway positioning systems, all machine room wiring, and hoistway wiring. The new controller would include the latest edition of fireman's emergency service, latest Accessibility functions, Hoistway Access Operation and Communications Verification Monitoring, all as required by present-day Code.

With an elevator control replacement, any desired special functions of the elevator controls should be discussed (i.e., card readers, cameras, car to lobby key switches, etc.) as it would be cost effective to add these functions with new control equipment in lieu of adding special operations at a later date.

HYDRAULIC PUMPING UNIT - The elevator hydraulic power unit (HPU) is the Dover Rota-flow model original to the 1967 installation. This power unit is of a dry type, consisting of a motor, pump, and control valve beneath the oil reservoir. The hydraulic control valve is the critical component on hydraulic pumping unit, as it controls the flow of the hydraulic fluid for speed and leveling. The valve type on this elevator is an upgraded Maxton valve. The catch pan below the power unit contained oil, indicative of a leak within the system (possibly at the muffler).



View of the Pump, Motor, and Maxton Control Valve

With any major renovation, it is recommended that the hydraulic power unit be replaced with new including pump, motor, control valve, and reservoir for guaranteed future performance for the next generation of use.

HYDRAULIC PLUNGER AND CYLINDER (JACK UNIT) – The elevator utilizes a direct plunger and cylinder (in-ground hydraulic jack unit) that is located in the ground to a depth approximately equal to the elevator travel height. The jack unit for Elevator No. 16 was replaced in 2007. The jack head was wet, and the collection bucket in the pit had 3-4 inches of oil, indicative of a leaking jack packing for the elevator.



The Elevator No. 16 Pit, Jack Unit, & Spring Buffers

With an elevator renovation, the existing jack assembly could be retained. Retention of the jack assembly would include dressing the plunger and replacing the jack packing. All old oil would be recycled, and the pump unit provided with new hydraulic oil. Due to the power unit in the machine room likely being relocated, some new supply line in the machine room will be required.

PIT EQUIPMENT - The buffer springs, stands, and pit channels appeared to be in good condition. They can be cleaned, painted, and retained with a renovation. The elevator pit ladder is located on the wrong side of the hoistway. A new Code-compliant ladder shall be provided on the opposite

(interlock) side of the entrance. This will require some shifting around of the elevator wire duct in the hoistway. Also, the current pit stop switch would be replaced with new and located to 18 inches above the access floor, adjacent to the pit ladder, to meet present-day requirements.

CAR PLATFORM, FRAME, GUIDES, AND GUIDE RAILS - The existing car platform and frame appears to be in good condition and can be retained with the renovation. The elevator utilizes slide guide assemblies, which can be retained and provided with new slide inserts to enhance ride quality. The platform guard on the elevator is of correct length, complies with present-day Elevator Code, and could be retained. The extruded aluminum car door sill is lathed and would be recommended to be replaced with new for the next generation of use, as the cab will be off the platform, and it would be the perfect time to perform this type of work.

Per present day code, protection shall be provided on any side of the car top where a fall hazard exists (over 12 inches from the top of car to the hoistway wall). This protection is usually a top of car handrail, but in this instance, a steel angle could be provided to reduce the existing 13.5 inches to less than 12 inches. The identified location where this will be required is on the North side. A new top of car operation device shall be provided for the elevator with an integral guarded light and GFCI duplex receptacle to meet current Code requirements.

The T-style guide rails and bracket fastenings can be retained with a renovation. The onus will be placed on the elevator installer to perform any required realignment to assure a smooth quality of ride for the elevator upon completion.

CAR ENCLOSURE – The elevator cab is in fair physical condition after years of passenger and service use. The cab is a Dover DLP cab, which is a cab constructed of wood and provided with a laminate interior finish. At some point, applied panels were added to the cab interior with photos of the campus and a plastic covering. The car jamb, header, and front return are satin stainless-steel. The car door has a painted finish with heavy scratching. There is a flat handrail present on the rear wall. The car has a non-standard suspended ceiling with lighting provided separately that is mounted above the ceiling to the underside of the canopy. The flooring consists of vinyl tile that shows signs of wear.



Elevator Cab Views

When a decision is made to perform a major renovation on the elevator, it is generally recommended the cab be given an aesthetic upgrade to give the passengers the perception the elevator is new upon completion of the work. As this cab is constructed of wood, it is difficult to renovate it without adding significant weight to the car or reducing the inside clearances. The existing interior applied panels do not meet Code, so replacement with similar applied panels is not an option. Therefore, the recommendation will be to totally replace the cab with a new stainless steel shell enclosure. The enclosure could be made of a rigidized 5WL pattern for a more durable

solution. Alternatively, it could be provided with new applied plastic laminate wall panels. A new handrail could be provided on the rear wall, as well as a new stainless steel car door, front return, header, and jamb. New, flush-mounted light fixtures could be provided in the elevator ceiling with LED lighting to maximize the inside cab height. A new blower fan could be provided for proper ventilation. New LVT flooring could be provided as well.



Example 5WL Stainless Steel Cab

DOOR OPERATION & PROTECTION- The existing door operator is the more modern MAC operator that replaced the original. This operator is no longer in production, and the future availability of parts will be impacted. Door operators are the piece of equipment that takes the most abuse over the life of the elevator and with any renovation, the recommendation would be to replace this system completely.

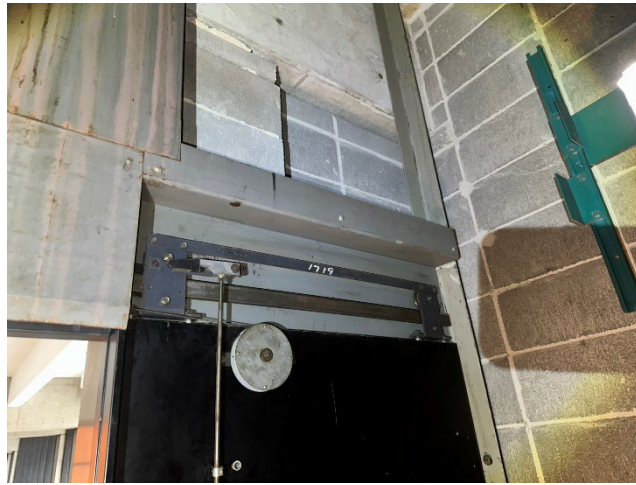


Existing MAC Door Operator

A renovation would include a new heavy-duty, closed-loop door operator, linkages, clutch, gate switch, infrared protection, and door restrictor.

HOISTWAY DOOR ASSEMBLIES - The hoistway entrances for Elevator No. 16 are the side-opening, single speed type with a 3'-0" width and 7'-0" height. The hoistway door panels and frames for the elevators are the original components. The door panels do have the U.L. 1½ hour fire rating labels as required by Building Code for each enclosure. There are unlocking holes at all floors for the

elevator. The door equipment consists of applied hangers, tracks, and headers bolted to the front hoistway walls. The doors have spirator closers. The existing entrance frames have a stainless-steel finish, and the entrance doors have a baked enamel finish at all floors.



Hoistway Side of Door Equipment (Typical)

With a renovation, the existing frames, door panels, sills, and headers can be retained. New hangers and tracks, unlocking devices, interlocks, spirator closers, and door relating cables shall be provided for improved door operation and proper interfacing with the new door operator.

Also, due to the installation date of the hoistway doors, there is the possibility the fireproofing materials in the hoistway door panels contain asbestos. The door panels shall be tested prior to any renovation, and if found to have asbestos, the panels shall be replaced with the renovation. *For the purposes of this report, the replacement of hoistway doors will be referred to as Alternate No. 1.*

It is recommended that the existing door jamb marking plates with Braille be replaced with new, inclusive of the star at Floor 1 to indicate the main egress floor. New elevator ID plates shall be installed in each jamb at the primary and alternate floors, per code. New applied fire evacuation signs shall be provided adjacent to the new hall button fixtures at each entrance, as required by code.

SIGNAL FIXTURES - The existing signal fixtures would be replaced with any renovation to increase reliability and include necessary provisions to meet Code requirements (fireman's emergency service) and Accessibility requirements. The following replacements would be required with a renovation:

- Car Control Station – The elevator currently has a single car control station located in the front return panel. A completely new car control station panel shall be provided for the elevator integral with the new front return. The new panel shall incorporate all appropriate buttons and key fixtures, digital car position indicator (with floor passing chimes), fireman's phase II fixtures in a locked cabinet (as presently required), emergency telephone, and emergency car light.



Car Control Station for Elevator No. 16

- **Hall Buttons** – There is currently one riser of surface-mounted hall buttons for the elevator. The existing riser of hall buttons will be removed, and new hall button stations shall be provided in the elevator hoistway entrance walls. The new hall button fixture faceplates should be oversized to cover any holes remaining from removal of the old fixtures. Due to the Architect's plan to Furr-out of the Floor 1 lobby, it is recommended that the fixture at that landing be flush-mounted, while the fixtures at Floors 2 and 3 can remain surface-mounted. The Floor 3 fixture shall also contain a hoistway access key switch.
- **Emergency Services Fixture** – A new emergency service fixture shall be provided for the elevator and located above the hall button station at Floor 1. This fixture shall include the fireman's emergency service key switch, illuminating fire hat jewel, engraved phase I instructions, and emergency communications verification functions. This fixture shall also contain a hoistway access key switch.
- **"In-Car" Hall Lantern** – There is currently an in-car hall lantern present in the strike jamb, although this lantern is located on the wrong side as it is not viewable from the hall button station as required by Code. A new "In-car" hall lantern shall be provided for the new elevator cab in the opposite return jamb location for the elevator. The lantern shall provide audible direction tones sounding once for up calls and twice for down calls when the car doors are $\frac{3}{4}$ open to meet Accessibility standards.
- **Hall Position Indicator** – There is a hall position indicator presently installed at Floor 1 only, above the elevator entrance. With an elevator replacement, a new flush mounted digital hall position indicator shall be provided to replace the existing and show the position of the car in the hoistway.

Outline Specification for Elevator Work

Based on the above analysis, the following brief outline is provided that summarizes the recommended Crag Hall Elevator No. 16 renovation work scope:

Renovate

One (1) holed, direct plunger hydraulic Elevator No. 16.

Machine & Jack Unit	Provide new hydraulic power unit in machine room. Retain the existing hydraulic jack unit drive. Replace jack packing.
Oil Line	Retain oil line; replace the machine room section as necessary with any relocation of power unit.
Capacity & Speed	Retain 2000 lbs. @ 125 fpm.
Operation	Provide new microprocessor controller with simplex collective operation with: <ul style="list-style-type: none"> Fireman's Emergency Service Independent Service Hoistway Access Key Switch Operation Communication Verification Operation
Approximate Travel	Retain 27'-2"
Number of Stops and Openings	Retain three (3) front landings at floors ★ 1, 2, and 3.
Opening Size	Retain 3'-0" wide by 7'-0" high opening.
Hoistway Entrances	Retain side-opening, single-speed design. <p>Retain door frames, panels, sills, and headers. Provide new hangers, tracks, closers, relating cables, interlocks, and unlocking devices, at each entrance.</p> <p><i>Alternate No. 1: Provide new hoistway doors.</i></p>
Door Operating Equipment	Provide new heavy-duty, closed loop door operator with new clutch, mechanical door restrictors, and door detectors.
Guide Rails	Retain and clean existing steel rails and realign, as necessary.
Car Structure	Retain existing car platform and sling. Provide new slide guide inserts. Provide new top of car inspection station, emergency exit interlock, and handrail system (or steel angle to reduce fall hazard), where required.
Buffers & Pit Equipment	Retain existing spring buffers and pit channels. Clean and paint.

	Provide new pit ladder on opposite interlock side. Provide new pit switch.
Car Enclosure	Provide new stainless steel 5WL cab shell, recessed LED flush mounted lighting, stainless steel return and car door, stainless steel handrail, blower fan, and new LVT flooring.
Signal Fixtures	
Car Control Station	Provide new single car control station with integral speakerphone, car position indicator, fireman's emergency services phase II cabinet, and emergency light in the front return panel and all required buttons and switches.
Hall Buttons	Replace existing riser of hall button stations with new, hall button fixtures. Floor 1 fixture to be flush-mounted and Floors 2 and 3 to be surface-mounted. Floor 3 fixture to contain hoistway access key switch.
Emergency Service Fixture	Provide new, separate fixture above Floor 1 hall button station containing FES and Communication Verification requirements. Provide hoistway access key switch.
"In-car" Hall Lantern	Provide new "In-car" hall lantern with illuminating arrows and adjustable electronic direction tones in opposite return jamb location.
Hall Position Indicator Fixture	At Floor 1 only, provide new stainless steel, flush mounted fixture with position indicator in the existing location above the entrance.
Warranty & Service	Provide 12 months Warranty. Provide full maintenance service from start of construction until 12 months after completion of the elevator.

Associated Building Work to be Performed with Renovation

When the elevator is to be provided with a complete renovation, there are several building work items related to the elevator renovation to be completed for interaction with the building system and code compliance that are not elevator work (Division 14) responsibility. These would come at an additional cost and become the responsibility of the Owner, or General Contractor:

Architectural

1. The elevator equipment is located at Floor 1 and is separated from a mechanical area by chain link fencing. The fact that the machine room is not fully enclosed presents some liabilities, including the difficulty to provide a dedicated HVAC system which is not fully enclosed and is open to a large

amount of equipment unrelated to the elevators. Another liability is that items unrelated to the elevator are not permitted within the room; the following items were noted:

- ITI SX-V panel on North wall
- Unrelated communication wiring that runs along the North and East wall.
- Access panel in West wall towards the South side
- Two unrelated pipes (possibly one drain line and one AC line) towards the South chain link fencing



Unrelated Equipment in Machine Room

Therefore, it is recommended to fully enclose the machine room with a new South wall with a fire rating that matches the hoistway. It is possible that this wall could be relocated approximately 18 inches to the North side (roughly in line with the beam running below the ceiling), so that the unrelated piping and access panel are removed from the room. The ITI SX-V panel and unrelated communication wiring shall be removed from the room, or alternatively, a new hardpan ceiling could be installed in the room below any unrelated equipment with a fire-rating that matches the room. A new machine room door shall be provided with a fire-rating that matches the room. The door shall be self-closing and self-locking, openable only without a key from inside the room.

2. The Division 14 elevator work will require the replacement of the hall button stations at each floor, along with the emergency service fixture and hall position indicator at Floor 1. Though the elevator specification will provide for oversized faceplates to cover old access holes, there is normally a need for some level of minor refinishing of the lobby walls around these fixtures, and this should be planned on with the renovation project (by other trades). Additionally, when the existing electrical cans for these fixtures cannot be re-used, new cans need to be installed. The initial plan will be to attempt to re-use the existing cans, though this may not be possible at all floors. The elevator contractor will make this determination. When required, other trades will need to provide fire patching/grouting behind these fixtures on the hoistway side to maintain the fire rating of the hoistway enclosure at these areas.
3. The existing entrance frames are stainless-steel, and the doors have a baked enamel finish at all landings. If a concern, re-painting of the hoistway entrance frames and doors (if doors are retained) for the elevator would be performed by other trades to coincide with the elevator renovation work. The entrance frames were pretty scuffed up and could be re-grained by a professional metals refinisher.
4. There were various penetrations in the machine room and elevator pit. These areas shall be patched, or fire caulked to restore the fire rating of the wall assemblies.

5. The elevator doors were likely installed in an era where asbestos was commonly used for fireproofing of hoistway doors. Due to this, the hoistway doors on the elevators shall be tested for asbestos before work begins to determine what, if any, level of abatement is needed. Should the hoistway door panels contain asbestos, the specifications shall have the doors replaced in their entirety with the renovation project and direct the elevator sub-contractor to stack them in a location to be addressed and properly disposed of by other sections.

Electrical/Fire Protection

6. The existing Square D mainline disconnect in the elevator machine room is fused, lockable, and does contain a 4th earth ground wire, as is required by modern elevator drive manufacturers. Others shall verify that this panel is of the proper size to handle the new equipment and meet Code requirements. The new hydraulic motor size is expected to not exceed the existing hydraulic motor size of 20 horsepower with the new pump unit, though this would need to be confirmed by the successful elevator contractor.



The Square D Mainline Disconnect

7. The elevator car lighting circuit is fed from a circuit breaker panel located in a closet on the second floor. The elevator will require its own, separate 120V, single phase disconnect panel in the machine room for the car lighting circuit that shall be installed with the renovation. The panel shall be lockable and fused and the circuit size shall be 15 amps. The new panel shall be installed utilizing all NEC requirements, including clearance requirements. Others would also be responsible for providing new conduit and wiring from the circuit breaker panel to the new elevator controller location.
8. The elevator machine room will require enhanced room lighting. The light fixtures shall be mounted such that 7'-0" of headroom clearance is maintained. A minimum of 19 foot-candles of illumination, as measured from the floor of the elevator machine room area throughout, shall be provided with a light switch adjacent to the elevator door. There was no receptacle inside the caged machine room area. A GFCI type receptacle shall be provided in the new machine room area.
9. The current lighting in the elevator pit is poor, and it shall be enhanced. Light fixtures shall be provided to ensure there is a minimum illumination level of 10 foot-candles measured at any point of the pit floor. This is typically achieved with dual-lamp, 48-inch LED light fixtures. A light switch shall be provided at the elevator's pit access location and located adjacent to the pit ladder. The pit receptacle is the non-GFCI type and shall be replaced with a GFCI receptacle.

10. Currently, there are smoke sensors located at the elevator lobby for Floors 1 and 3. Smoke sensors will need to be added at the Floor 2 elevator lobby and in the elevator machine room. The existing fire alarm control shall be investigated, and any necessary modifications made to assure that the appropriate number of signals can be provided to the elevator control system to allow for the following actions:

- Action 1: When the smoke sensor is activated in any of an elevator's lobbies, other than the Floor 1 lobby, the car shall return to the main fire return Floor 1 and open its doors. The fire hat jewel inside the car shall illuminate solid.
- Action 2: When the smoke sensor is activated in the main fire return Floor 1 lobby, the car shall return to the alternate return floor 2 and open its doors. The fire hat inside the car shall illuminate solid.
- Action 3: When the smoke sensor is activated in the elevator machine room, the car shall return to the alternate return floor 2 and open its doors. The fire hat jewel inside the elevator car shall illuminate intermittingly (flash).

Different elevator control systems require different signals; coordination of required components will be required between elevator installer and the electrical / fire alarm subcontractor.

Mechanical & Plumbing

11. In the machine room, there is currently a supply and return vent in the room. With a renovation, a dedicated HVAC system shall be provided that is capable of maintaining the machine room between 50 degrees and 90 degrees Fahrenheit with a relative humidity below 95% for proper operation of the microprocessor control equipment. The estimated heat release from the elevator equipment in the machine room during heavy use is 10,000 BTUs per hour. This information shall be analyzed, and a proper HVAC system installed to meet the requirements. HVAC equipment shall not be located directly over elevator equipment.



Supply/Return Vents in Machine Room

Costs & Duration Matrix Schedule

This report describes the needs of elevators at the Craig Hall building located at Missouri State University. Below, a renovation cost and duration schedule has been put together for the Owner's reference and use in assessing the Division 14 work in the project.

ELEVATOR SCOPE (Per This Report)	Estimated Duration	* Est. Costs
Engineering, Shop Drawings, Lead Times for Major Components;	24 weeks	
Renovate Craig Hall Elevator No. 16	5 weeks	\$166,500
<i>Alternate No. 1: Provide New Hoistway Doors</i>	<i>1 week total</i>	<i>\$15,000 Total</i>
Totals for Base Elevator Renovation	29 weeks	*\$166,500
<i>Totals for Elevator Renovation with Alternate No. 1</i>	30 weeks	*\$181,500

* These costs reflect only the Division 14 (Elevator Work) costs for the scopes of work outlined in this report. **These costs do not reflect the costs of the necessary associated building work items that have been identified or any associated general contractor mark-up (when applicable).**

When you have reviewed this report, please contact our office and we shall schedule a meeting to review and answer all questions.

Best regards,

Sean McLaughlin

Sean McLaughlin
Elevator Consultant

SECTION 20 00 00 – BASIC MECHANICAL CONDITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provisions and conditions cited in this Section shall apply to Work for other sections of Divisions 22 of these Specifications.
- C. The following sections of the Specifications apply to Work under this Section
 - 1. Division 21 – Fire Protection System
 - 2. Division 22 – Plumbing Work
 - 3. Division 23 – HVAC Piping and Equipment
 - 4. Division 24 – Air Distribution
 - 5. Division 25 – Temperature Control System
 - 6. Section 20 05 48 – Seismic Control
 - 7. Section 20 05 49 – Vibration Control
 - 8. Section 20 10 00 – Basic Mechanical Methods
 - 9. Section 20 10 10 – Basic Piping Materials
 - 10. Section 20 10 20 – Valves and Strainers
 - 11. Section 20 10 30 – Hangers, Shields, Supports, and Anchors
 - 12. Section 20 10 40 – Sleeves and Seals
 - 13. Section 20 10 50 – Basic Mechanical Methods – Related Work
 - 14. Section 20 10 60 – Testing Adjusting and Balancing
 - 15. Section 20 10 70 – Identification
 - 16. Section 20 20 10 – Electrical Requirements
 - 17. Section 20 20 10 – Drives and Guards
 - 18. Section 20 20 25 – Insulation

1.2 SUMMARY

- A. Section Includes:
 - 1. Seismic Control for the work of Divisions 20 - 25.
 - 2. Vibration Control for the work of Divisions 20 - 25.
 - 3. Identification of piping and equipment for the work of Divisions 20 - 25.
 - 4. Testing, adjusting and balancing of systems for the work of Divisions 20 - 25.
 - 5. Cleaning of piping and equipment for the work of Divisions 20 - 25.
 - 6. Excavation, trenching and backfilling for the work of Divisions 20 - 25.
 - 7. Painting of piping and equipment for the work of Divisions 20 - 25.
 - 8. Demolition for the work of Divisions 20 - 25.
 - 9. Concrete for the work of Divisions 20 - 25.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 20 00 00

SECTION 20 05 48 – SEISMIC CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Restraints - rigid type.
 - 2. Restraints - cable type.
 - 3. Restraint accessories.
 - 4. Post-installed concrete anchors.
 - 5. Concrete inserts.
- B. Related Requirements:
 - 1. Section 20 00 00 BASIC MECHANICAL CONDITIONS

1.2 DEFINITIONS

- A. Designated Seismic System: A Fire Protection, Plumbing, or HVAC component that requires design in accordance with ASCE/SEI 7, Ch. 13 – Seismic Design for Nonstructural Components, and as required by local code, and as a required on the Drawings.
- B. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the Section Text is [ASCE/SEI 7-05] [ASCE/SEI 7-10 including supplement No. 1] [ASCE/SEI 7-16] .
- C. IBC: International Building Code.
- D. ICC-ES: ICC Evaluation Service, LLC. A Subsidiary of the International Code Council.
- E. Seismic Listing Agency: ICC-ES product listing, UL product listing, FM Approvals, an evaluation service member of ICC-ES, an agency acceptable to authorities having jurisdiction.
- F. OSHPD: Office of Statewide Health Planning and Development (State of California).
- G. Professional Engineer: Professional Engineer registered in the state of Missouri.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Include load rating for each wind-force-restraint fitting and assembly.
 - 3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-[and wind-force-]restraint component.

4. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by a Seismic Listing Agency.
 5. Annotate to indicate application of each product submitted and compliance with requirements.
 6. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
1. Detail fabrication and assembly of equipment bases.
 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated Design Submittals:
1. For each seismic-restraint [and] [wind-load protection] device, including [seismic-restrained mounting,] [pipe-riser resilient support,] [snubber,] [seismic restraint,] [seismic-restraint accessory,] [concrete anchor and insert,] [and] [restrained isolation roof-curb rail] that is required by this Section or is indicated on Drawings, submit the following:
 2. Seismic [and Wind-Load] Restraint, and Vibration Isolation Base Selection: Select vibration isolators, seismic [and wind-load] restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
 3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
 4. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
 5. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
 6. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
 7. Qualified Professional Engineer: All designated-design submittals for seismic- and wind-restraint calculations are to be signed and sealed by qualified Professional Engineer responsible for their preparation.
 8. Seismic-[and Wind-]Restraint Detail Drawing:
 - a. Design Analysis: To support selection and arrangement of seismic [and wind] restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.
 9. All delegated design submittals for seismic- and wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.

10. Product Listing, Preapproval, and Evaluation Documentation: By a Seismic Listing Agency, showing maximum ratings of restraint items and basis for approval (tests or calculations).
11. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
12. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.4 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.
- B. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for Fire Protection, Plumbing, and HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- C. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.
 1. Provide equipment manufacturer's written certification for each designated active mechanical seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270 (AHRI 1271), including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction or experience data as permitted by ASCE/SEI 7.
 2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7.
 3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.
 4. The following HVAC systems and components are Designated Seismic Systems and require written special certification of seismic qualification by manufacturer:
 - a. —
- D. Wind-Force Performance Certification: Provide special certification for HVAC components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.
 1. Provide equipment manufacturer's written certification for each designated HVAC device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
 2. Provide manufacturer's written certification for each designated louver, damper, or similar device, stating that it will remain in place and protect opening from penetration of windborne debris and comply with all requirements of authorities having jurisdiction.
 3. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.

4. The following HVAC systems and components require special certification for high wind performance. Written special certification of resistance to the effects of high wind force and impact damage must be provided by manufacturer:
 - a. _____ CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.
- C. As-built seismic drawings with sealed letter from Seismic engineer stating that the completed installation meets the design.

1.6 QUALITY ASSURANCE

- A. Seismic-[and Wind-Load-]Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified Professional Engineer, to design seismic [and wind-load] control system.
 1. Seismic [and Wind-Load] Performance: Equipment to withstand the effects of earthquake motions and high wind events determined in accordance with ASCE/SEI 7.
- B. Seismic Design Calculations:
 1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7.
 2. Data indicated below to be determined by Delegated Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
 3. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
 4. See drawings for Building Occupancy Category, Building Risk Category, Building Site Classification and component or system importance factor.
 5. See structural drawings for calculation factors.
- C. Consequential Damage: Provide additional seismic restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in ASCE/SEI 7 so that failure of a non-essential or essential HVAC component will not cause failure of any other essential architectural, mechanical, or electrical building component.

- D. Fire/Smoke Resistance: Seismic- and wind-load-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- E. Component Supports:
 - 1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
 - 2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7.

2.2 MANUFACTURERS

- A. Seismic Restraints and Accessories
 - 1. Amber/Booth
 - 2. Eaton
 - 3. Gripple
 - 4. Isotech
 - 5. Kinetics Noise Control
 - 6. Loos & Co., Inc.
 - 7. Mason Industries
 - 8. Approved equivalent
- B. Post-installed concrete anchors.
 - 1. Concrete Fastening Systems
 - 2. Hilti
 - 3. ITW Red Head
 - 4. MKT
 - 5. Powers
 - 6. Simpson Strong-Tie
 - 7. Approved equivalent

2.3 RESTRAINTS - RIGID TYPE

- A. Source Limitations: Obtain rigid-type restraints from single manufacturer.
- B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.4 RESTRAINTS - CABLE TYPE

- A. Source Limitations: Obtain cable-type restraints from single manufacturer.
- B. Seismic-Restraint Cables: Pre-stretched galvanized-steel or stainless-steel aircraft cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for

seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

- C. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.5 RESTRAINT ACCESSORIES

- A. Source Limitations: Obtain restraint accessories from single manufacturer.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.6 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts:
 - 1. Source Limitations: Obtain mechanical anchor bolts from single manufacturer.
 - 2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.
- B. Adhesive Anchor Bolts:
 - 1. Source Limitations: Obtain adhesive anchor bolts from single manufacturer.
 - 2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- C. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-16, Ch. 13.
 - 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.

2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

2.7 CONCRETE INSERTS

- A. Source Limitations: Obtain concrete inserts from single manufacturer.
- B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.
- C. Comply with ANSI/MSS SP-58.

2.8 SNUBBERS

- A. Source Limitations: Obtain snubbers from single manufacturer.
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-14 Ch. 17.
 2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
 3. Anchors in Masonry: Design in accordance with TMS 402.
 4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic and wind control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by a Seismic Listing Agency.
- B. Hanger-Rod Stiffeners: Install where indicated or scheduled on the Seismic Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static, wind load, and seismic loads within specified loading limits.

3.3 INSTALLATION OF SEISMIC- AND WIND RESTRAINT DEVICES

- A. Provide seismic-restraint and wind-load control devices for systems and equipment where indicated on the Drawings, where indicated on the Seismic Drawings, where Specifications indicate they are to be installed on equipment and systems, and where required by applicable codes.
- B. Install seismic-restraint devices using methods approved in accordance with their listing and manufacturer's instructions.
- C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- D. Installation of seismic, wind-load restraints, must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- E. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- F. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint, and wind-load-restraint devices using methods approved by [an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- G. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- H. Ductwork Restraints:
 - 1. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." and ASCE/SEI 7.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
 - 4. Select seismic-restraint devices with capacities adequate to carry static and seismic loads.
 - 5. Install cable restraints on ducts that are suspended with vibration isolators.

- I. Install seismic-[and wind-load-]restraint cables so they do not bend across edges of adjacent equipment or building structure.
- J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- M. Mechanical Anchor Bolts:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements for piping flexible connections.

END OF SECTION 20 05 48

SECTION 20 05 49 – VIBRATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Elastomeric isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Open-spring isolators.
 - 5. Housed-spring isolators.
 - 6. Restrained-spring isolators.
 - 7. Housed-restrained-spring isolators.
 - 8. Pipe-riser resilient support.
 - 9. Resilient pipe guides.
 - 10. Air-spring isolators.
 - 11. Restrained-air-spring isolators.
 - 12. Elastomeric hangers.
 - 13. Spring hangers.
 - 14. Vibration isolation equipment bases.
 - 15. Restrained isolation roof-curb rails.
- B. Related Requirements:
 - 1. Section 20 00 00 BASIC MECHANICAL CONDITIONS

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.
- B. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for Fire Protection, Plumbing, and HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.

- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Where vibration isolation products are Restrained Type used on equipment or systems that are required to be seismically restrained, follow the additional requirements of 20 05 48 Seismic Controls.

2.2 MANUFACTURERS

- A. Vibration Isolation Products:
1. Amber/Booth
 2. Isotech
 3. Kinetics Noise Control
 4. Korfund
 5. Mason Industries
 6. Thybar
 7. Vibra Systems
 8. VMC Group
 9. Approved equivalent

2.3 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
1. Source Limitations: Obtain elastomeric isolation pads from single manufacturer.
 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 3. Size: Factory or field cut to match requirements of supported equipment.
 4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
 5. Surface Pattern: Smooth, ribbed, or waffle pattern.

2.4 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:
1. Source Limitations: Obtain double-deflection, elastomeric isolation mounts from single manufacturer.
 2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded[with threaded studs or bolts].
 - b. [Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.]
 3. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.5 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts

1. Source Limitations: Obtain restrained elastomeric isolation mounts from single manufacturer.
2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.6 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Source Limitations: Obtain freestanding, laterally stable, open-spring isolators from single manufacturer.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates limit floor load to 500 psig (3447 kPa).
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.7 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

1. Source Limitations: Obtain freestanding, laterally stable, open-spring isolators in two-part telescoping housing from single manufacturer.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
 - b. Top housing with [attachment and leveling bolt] [threaded mounting holes and internal leveling device] [elastomeric pad].

2.8 RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
 - 1. Source Limitations: Obtain restrained-spring isolators from single manufacturer.
 - 2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
 - b. Top plate with threaded mounting holes
 - c. Internal leveling bolt that acts as blocking during installation.
 - 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 - 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 HOUSED-RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
 - 1. Source Limitations: Obtain freestanding, open-spring isolators with vertical-limit stop restraints from single manufacturer.
 - 2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
 - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.10 PIPE-RISER RESILIENT SUPPORT

- A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch-Thick Neoprene
 - 1. Source Limitations: Obtain all-directional, acoustical pipe anchor from single manufacturer.
 - 2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 - 3. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.11 RESILIENT PIPE GUIDES

- A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch-Thick Neoprene:
 - 1. Source Limitations: Obtain resilient pipe guides from single manufacturer.
 - 2. Factory-Set Height Guide with Shear Pin: Shear pin to be removable and reinsertable to allow for selection of pipe movement. Guides to be capable of motion to meet location requirements.

2.12 AIR-SPRING ISOLATORS

- A. Freestanding, Single or Multiple, Compressed-Air Bellows:
 - 1. Source Limitations: Obtain air-spring isolators from single manufacturer.
 - 2. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
 - 3. Maximum Natural Frequency: 3 Hz.
 - 4. Operating Pressure Range: 25 to 100 psig.
 - 5. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
 - 6. Automatic leveling valve.

2.13 RESTRAINED-AIR-SPRING ISOLATORS

- A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint:
 - 1. Source Limitations: Obtain restrained-air-spring isolators from single manufacturer.
 - 2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
 - b. Top plate with [threaded mounting holes] [elastomeric pad].
 - c. Internal leveling bolt that acts as blocking during installation.
 - 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 7. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
 - 8. Maximum Natural Frequency: [3 Hz] <Insert frequency>.
 - 9. Operating Pressure Range: 25 to 100 psig.
 - 10. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
 - 11. Automatic leveling valve.

2.14 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
 - 1. Source Limitations: Obtain elastomeric hangers from a single manufacturer.

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.15 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
1. Source Limitations: Obtain spring hangers from single manufacturer.
 2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 8. Retain "Adjustable Vertical Stop" Subparagraph below if a vertical-limit stop is required.
 9. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 10. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.16 VIBRATION ISOLATION EQUIPMENT BASES Source Limitations: Obtain vibration isolation equipment bases from single manufacturer.

- B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails to have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases to have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

- D. Concrete Inertia Base: Factory-fabricated welded structural-steel bases and rails ready for placement of cast-in-place concrete.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases to have shape to accommodate supported equipment. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 - 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.17 RESTRAINED ISOLATION ROOF-CURB RAILS

- A. Source Limitations: Obtain restrained isolation roof-curb rails from single manufacturer.
- B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.
- C. Upper Frame: To provide continuous support for equipment and to be captive to resiliently resist seismic and wind forces.
- D. Lower Support Assembly: To be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. Lower support assembly to have a means for attaching to building structure and a wood nailer for attaching roof materials, and to be insulated with a minimum of 2 inches (50 mm) of rigid, glass-fiber insulation on inside of assembly. Mount adjustable, restrained-spring isolators on elastomeric vibration isolation pads and provide access ports, for level adjustment, with removable waterproof covers at all isolator locations. Locate isolators so they are accessible for adjustment at any time during the life of the installation without interfering with integrity of roof.
- E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
- F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic and wind control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF VIBRATION-CONTROL DEVICES

- A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Devices Schedules, where indicated on Drawings, or where Specifications indicate they are to be installed on specific equipment and systems.
- B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork.
- C. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- D. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- F. Mechanical Anchor Bolts:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.3 INSTALLATION OF AIR-SPRING ISOLATORS

- A. Independent Isolator Installation:
 - 1. Install tank valve into each air isolator.
 - 2. Inflate each isolator to [height] [and] [pressure] specified on Drawings.
- B. Pressure-Regulated Isolator Installation:

1. Coordinate the constant pressure-regulated air supply to air springs with requirements for piping and connections specified in Section 221513 "General-Service Compressed-Air Piping."
2. Connect all pressure regulators to a single dry, filtered [facility] [constant] air supply.
3. Inflate isolators to [height] [and] [or] [pressure] specified on Drawings.

3.4 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

- A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork.
- B. Coordinate dimensions of steel equipment rails and bases, concrete inertia bases, and restrained isolation roof-curb rails with requirements of isolated equipment specified in this and other Sections. Where dimensions of these bases are indicated on Drawings, dimensions may require adjustment to accommodate actual isolated equipment.

3.5 ADJUSTING

- A. Adjust isolators after system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION 20 05 49

SECTION 20 10 00 – BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Arrangement of Work
 - 2. Coordination
 - 3. Delivery, Storage and Handling
 - 4. General Cleaning
 - 5. Cleaning of Piping Systems
 - 6. Pressure Testing
- B. Related Requirements:
 - 1. Section 20 00 00 BASIC MECHANICAL CONDITIONS

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 ARRANGEMENT OF WORK

- A. All Work shall be arranged so that hangers and supports for the mechanical equipment and materials shall be within the load limitations of the structure and the respective hanger and/or support.
- B. Contractor shall not scale from drawings to determine the exact locations for devices, piping, ductwork, etc., but shall follow the architectural drawings, the structural drawings and the actual building conditions, in establishing dimensions and lines of run. The work shall be adjusted to accommodate interferences anticipated and encountered. The Contractor shall verify the exact material quantities and lengths required.
- C. Piping that is required to pitch shall have priority over piping that does not pitch. Work which cannot be changed in elevation shall have priority over that which can be moved. Offsets, transitions and changes in direction shall be made in piping and ductwork to maintain headroom and pitch whether or not indicated on the Plans. The Contractor shall provide air vents, traps, dirt legs, drains, lifts, sanitary vents, mechanical vent lines, etc. as required to install the mechanical systems for proper operation and maintenance.
- D. Do not install work in the immediate proximity of electrical components (e.g. - panels, switches, controls, boxes, etc.) in equipment rooms. Drip pans above and/or around electrical equipment are not permitted.
- E. Aluminum and copper products shall not be encased in concrete.

- F. Work in “finished spaces” shall be concealed within walls, chases or above the ceiling unless specifically indicated otherwise. Install the Work to coordinate with other trades and to conform to the architectural reflected ceiling plan.
- G. The work shall be installed parallel with the building lines unless specifically shown or noted otherwise.

3.2 COORDINATION

- A. [Each Contractor shall prepare and submit coordination drawings (at a scale equal to or larger than the project documents) to the Architect/Engineer for review prior to any fabrication or installation.]
- B. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results, where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- C. It shall be the Contractor's responsibility to coordinate their work with the work of other trades, and with the architectural and structural drawings. Where physical interferences cannot be resolved between the trades, or when encountered in the field, the Contractor shall prepare composite drawings at a scale of not less than $3/8" = 1'-0"$ clearly showing the Work of Divisions 20 - 29 in relation to the Work of others to identify the conflict. Submit a proposed resolution to the Architect/Engineer for approval in accordance with Sub-sections 20 00 01, GENERAL (Project Documents) and 20 10 06, SUBMITTALS.
 - 1. Do not proceed with Work in question until the matter is mutually resolved among the involved parties, and adequate information has been submitted to the Architect/Engineer for review. No additional compensation shall be granted for modifications and execution of the resolution(s). Modifications are to be incorporated in the “as-built” drawings.
- D. Contractor shall review the Project Documents, site conditions, and the requirements of other disciplines, and shall report any discrepancies between them to the Architect/Engineer and obtain from him written permission for changes necessary in the Mechanical Work. Subsequent clarification(s) by the Architect/Engineer will not be a change in scope of the Work. The Contractor at no addition in the contract price shall perform any such modifications required.
- E. Contractor shall verify tie-in locations to verify sizes, direction of flow (via pressure or physical tracing, not labels), materials, elevations, etc. prior to commencing new work. Contractor shall notify Architect/Engineer upon discovery of discrepancy. Work performed prior to verification will be corrected at no cost to Owner.
- F. The drawings shall not be scaled; obtain detailed information, shop drawings, installation and maintenance bulletins, etc. to determine exact requirements and to satisfactorily achieve the intent of the Project Documents.

- G. The Contractor shall furnish and properly install all sleeves, slots, chases, openings, recesses, supports, anchors and anchor bolts required for his Work in coordination with the other trades as the building is erected.
- H. The expenses for changes required by neglect in executing, coordinating or scheduling the Work properly or avoiding conflicts shall be borne by the Contractor precipitating the issue requiring the changes.

3.3 DELIVERY, STORAGE AND HANDLING

- A. Delivery, storage and handling of equipment and material are the Contractor's responsibilities. The Contractor shall perform the Work in accordance with the following criteria:
 - 1. Delivery shall be arranged by the Contractor (including Owner furnished items) for the expeditious and economical pursuit of the Work and to meet the scheduling requirements of the Contract.
 - 2. The Contractor will be assigned a "lay-down" area at the job site and shall confine temporary storage to this area.
 - 3. The Contractor may take delivery of equipment and material at his "shop" or an off-site location as suits the performance and schedule of the Work.
 - 4. Regardless of where and how equipment and material are temporarily stored prior to installation, or if installed at the job site prior to acceptance, the Contractor is responsible for the following:
 - a. All equipment and material shall be accessible to the Architect/Engineer for inspection.
 - b. All equipment and material shall be protected adequately and properly from the weather, dirt and water, chemical, mechanical or comprehensive damages.
 - c. The Contractor shall be liable for the repair and/or replacement (including labor) of any equipment and material lost, damaged or defective prior to acceptance.
 - 5. The Contractor shall arrange all labor, tools, services and scheduling to perform the handling of equipment and material for his Work.

3.4 GENERAL CLEANING

- A. Each Contractor and Subcontractor shall be responsible for progress and final clean-up of his respective Work in accordance with the Contract Documents, requisite ordinances and regulations. Clean-up and legal disposal of debris from the Work, excess refuse and presence at the job site shall be performed in a timely and satisfactory manner. If not, the Contractor shall be notified of the unsatisfactory condition. If the matter persists, the Contractor will be back charged for the clean-up performed by others.
- B. Clean exposed exteriors and limited access interior surfaces of all equipment, piping and ductwork of foreign matter to provide an "as new" condition.

3.5 CLEANING OF PIPING SYSTEMS

- A. The Contractor shall clean the respective piping system(s) that are included in his scope of work. All systems shall be flushed with water or air (depending on ultimate use) to relieve any congestion and internally cleanse the respective piping system. The Contractor shall provide all flushing

- media in sufficient quantity, inlet connections, discharge or drainage outlets and any temporary provisions to protect components, or remove it, to facilitate the flushing. Clean and replace all strainer screens and filters. Flush clean and drain all low points in the piping.
- B. Owner's representative shall be present for flushing, cleaning, and rinsing. Water treatment representative must check water after rinsing to insure all chemical cleaner has been removed and the Alkalinity of the rinse water is equal to that of the make-up water.
- C. All pipe systems for hydronic applications including non-potable water system shall be flushed continuously with 100% city water make-up until the water runs clean from all drain locations. Each piping system shall be subsequently cleaned with recommended dosage of an approved pre-cleaning chemical designed to remove deposition such as pipe dope, oils, loose rust, mill scale and other extraneous materials for a minimum period of twenty-four (24) hours then drained, refilled, and rinsed clean. Flushing before and rinsing after cleaning shall be supplying constant make-up water while draining at all system low points and drains.
- D. Steam and condensate return piping shall be flushed continuously with 100% city water make-up until the water runs clean from all drain locations. Each piping system shall be subsequently cleaned with recommended dosage of an approved pre-cleaning chemical designed to remove deposition such as pipe dope, oils, loose rust, mill scale and other extraneous materials for a minimum period of twenty-four (24) hours then drained, refilled, and rinsed clean. Flushing before and rinsing after cleaning shall be by supplying constant make-up water while draining at all system low points and drains.
- E. New or repaired potable water systems shall be purged of deleterious matter and disinfected prior to utilization. The method to be followed shall be that prescribed by the health authority having jurisdiction or, in the absence of a prescribed method, the procedure described in either AWWA C651 or AWWA C652, or as described in this section. This requirement shall apply to "on-site" or "in-plant" fabrication of a system or to a modular portion of a system.
- F. Document the materials, the chemicals to be used, the concentration in ppm, the contact time and who is performing the work. Document the date, time and data from the entire flushing and disinfection process and keep records to show that such processes were performed.
1. Locate chemical injection points and flushing locations.
 2. Pre-mix disinfection chemicals in tanks or establish a flow-proportioning pump that can be accurately controlled with a chlorine meter.
 3. Establish a procedure for flushing water at every fixture, a required number of simultaneous fixtures to be flushed and a schedule of flushing times.
 4. Turn off the hot water system and flush out hot water that can affect the chemical oxidation rate.
 5. Flush the cold and hot water systems with water at approximately 3 feet/second velocity until the water runs clear at every fixture. This removes dirt, sediment and debris.
 6. Fill the system with a water-chlorine solution; flow water from every fixture until water treatment chemical residuals of a sufficient amount are present.
 7. Measure the water treatment chemical residual at remote fixtures at the beginning, at regular intervals and at the end of the contact time period.
- G. Water quality acceptance test(s) required shall include: Total Coliform, e-coli, pH, Alkalinity, Turbidity. Test potable water from nearby source as a reference sample.

3.6 PRESSURE TESTING

- A. Entire piping systems shall be pressure tested at one time unless it is not possible or practical. When partial testing is required, the Contractor shall submit a test plan.
- B. All piping to be insulated or concealed shall be pressure tested prior to the application of the insulation or concealment.
- C. A representative of the Architect/Engineer shall witness all pressure testing. The Contractor shall notify the Architect/Engineer at least three (3) days prior to the test date.
- D. Each piping system shall be tested per the method, test pressure, and test duration as specified in the Piping Application Schedules.
- E. The Contractor shall provide all test media, measuring devices, inlet connections, test measurement connections, and disposal of test media. The Contractor shall protect, isolate and/or remove piping system components that can not be subjected to test pressures.
- F. Hammer each joint in welded or soldered piping while under test. Leaks shall be repaired and the test(s) repeated until the respective piping system is tight.
- G. Prepare written report of testing.

END OF SECTION 20 10 00

SECTION 20 10 10 – BASIC PIPING MATERIALS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Copper tube and fittings.
 - 2. Steel pipe and fittings.
 - 3. Stainless steel pipe and fittings.
 - 4. Plastic pipe and fittings.
 - 5. Cast iron pipe and fittings.
 - 6. Ductile iron pipe and fittings.
 - 7. High Density Polyethylene
 - 8. Polyethylene pipe and fittings.
 - 9. CCST pipe and fittings.
 - 10. Fiberglass pipe and fittings.
 - 11. Piping joining materials.
 - 12. Transition fittings.
 - 13. Dielectric fittings.
- B. Related Requirements:
 - 1. Section 20 00 00 BASIC MECHANICAL CONDITIONS

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.
- B. Welding certificates.
- C. Qualification Data: For Installer.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:

1. HDPE pipe
 2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP are to be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.
 3. Installers of Grooved Joints: Installers are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- B. Pipe Welding: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX.
1. Comply with ASME B31.9 for materials, products, and installation.
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- 1.6 WARRANTY
- A. Grooved fittings and couplings Manufacturer's Warranty: Manufacturer agrees to repair or replace couplings and fittings that fail in materials or workmanship within 20 years from date of Substantial Completion.
1. Warranty is to cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.
 2. Warranty is to be in effect only upon submission by Contractor to manufacturer of valid pressure/leak documentation indicating that the system was tested and passed manufacturer's pressure/leak test and any other manufacturer requirements.
- B.
- C. PP-R and PP-RCT Manufacturer's Warranty: Manufacturer agrees to repair or replace PP-R and PP-RCT pipe and fittings that fail in materials or workmanship within 10 years from date of Substantial Completion.
1. Warranty is to cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.
 2. Warranty is to be in effect only upon submission by Contractor to manufacturer of valid pressure/leak documentation indicating that the system was tested and passed manufacturer's pressure/leak test and any other manufacturer requirements.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88 types K & L.
- B. Annealed-Temper Copper Tube: "Soft" copper tube ASTM B88 type K
- C. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.

- D. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- E. Refrigeration ACR Tube: ASTM B280
- F. Oxygen Service: ASTM B819
- G. Cast-Copper, Solder-Joint Fittings: ASME B16.18 pressure fittings.
- H. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings.
- I. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- J. Cast-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.
- K. Wrought-Copper Unions: ASME B16.22.
- L. Copper-Tube, Mechanically Formed Tee Fitting: For forming T-branch on copper water tube.
 - 1. Description: Tee formed in copper tube in accordance with ASTM F2014.
- M. Grooved, Mechanical-Joint, Copper Tube Fittings and Couplings
 - 1. Source Limitations: Obtain grooved mechanical-joint copper tube fittings and couplings from single manufacturer.
 - 2. Grooved-End Copper Fittings: ASTM B75 (ASTM B75M) copper tube or ASTM B584 bronze castings.
 - 3. Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting EPDM gasket rated for minimum 230 deg F for use with ferrous housing, and steel bolts and nuts; 300 psig (2060 kPa) minimum CWP pressure rating.
- N. Solder Filler Metals: ASTM B32, lead-free alloys.
- O. Flux: ASTM B813, water flushable.
- P. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M black steel with plain ends; welded and seamless, Grade B, and schedule number as indicated in Part 3, "Piping Applications" Article.
- B. Steel Pipe: ASTM A106 black steel with plain ends; seamless, Grade A, and schedule number as indicated in Part 3, "Piping Applications" Article.
- C. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3, "Piping Applications" Article.
- D. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3, "Piping Applications" Article.

- E. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3, "Piping Applications" Article.
- F. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.
- G. Wrought-Steel Fittings: ASTM A234/A234M; wall thickness to match adjoining pipe.
- H. Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- I. "Weldolets, Thredolets, Sockolets and Elbolets": In accordance with ANSI B36.10/ASTM A216, except Elbolets which are ANSI B16.11. Weldolets available standard and extra strong, black only, range 1/8" - 24". Others available 3000# and 6000#, black only, range 1/8" - 4" (limited).
- J. Grooved Mechanical-Joint Fittings and Couplings Source Limitations: Obtain grooved mechanical-joint fittings and couplings from single manufacturer.
 - 2. Joint Fittings: ASTM A536, Grade 65-45-12 ductile iron; ASTM A47/A47M, Grade 32510 malleable iron; ASTM A53/A53M, Type F, E, or S, Grade B fabricated steel; or ASTM A106/A106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts and bolts to secure grooved pipe and fittings. Segmentally welded fittings are not acceptable.
 - 3. Couplings: Ductile- or malleable-iron housing and EPDM gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
 - 4. Only the following fittings will be accepted: Long radius (1.5 x diameter) 90° and 45° elbows, tee, reducing tee, concentric/eccentric reducers, and flange adapter nipples. Flange rings, reducing couplings, saddle/mechanical/clamp branch tee, and others not listed above are not acceptable.
- K. 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.

2.3 PLASTIC PIPE AND FITTINGS

- A. PVC Plastic Pipe: ASTM D1785, with wall thickness as indicated in "Piping Applications" Article.
 - 1. PVC Socket Fittings:
 - a. ASTM D2466 for Schedule 40
 - b. ASTM D2467 for Schedule 80.
 - 2. PVC Schedule 80 Threaded Fittings: ASTM D2464.
 - 3. Solvent Cements for PVC Piping: ASTM D2564. Include primer in accordance with ASTM F656.
- B. DWV PVC Plastic Pipe:
 - 1. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.
 - 2. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.

3. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. CPVC Plastic Pipe: ASTM F441/F441M, with wall thickness as indicated in "Piping Applications" Article.
 1. CPVC Socket Fittings:
 - a. ASTM F438 for Schedule 40
 - b. ASTM F439 for Schedule 80.
 2. CPVC Threaded Fittings: ASTM F437, Schedule 80.
 3. Solvent Cements for CPVC Piping: ASTM F493.
- D. Smoke and Fire Ratings:
 1. Where indicated on Drawings that a plenum-rated piping system is required, the pipe is to be wrapped and/or insulated with fiberglass or mineral wool pipe insulation; field installed.
 - a. The system is to have a flame-spread classification of less than 25 and smoke-developed rating of less than 50.
 - b. Pipe, wrap, or insulation as a system to comply with the requirements of ASTM E84, or UL 2846.
 - c. For insulation required for thermal and condensation conditions, see Section 230719 "HVAC Piping Insulation."

2.4 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings:
 1. Standards: ASTM A74.
 2. All cast iron soil pipe and fittings shall be 3rd party certified by CISPI or ANSI accredited third party auditing firms to the complete standards, including Annex A1.
 3. Warranty: 5 years
 4. Manufacturers: Charlotte Pipe and Foundry, Tyler Pipe and Coupling, AB&I Foundry, New Age Castings
- B. Gaskets: ASTM C564, rubber.
- C. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.
- D. Epoxy coating:
 1. Boring: Interior of pipe to be bored/reamed for smoothness prior to coating
 2. Pipe and fitting interior: Minimum 5 mils
 3. Pipe and fitting exterior: Minimum 2.5 mils
 4. Epoxy touch up: Manufacturer to provide product.
 5. Performance Testing: 3rd party testing Per EN 877
 - a. Resistance to salt spray
 - b. Resistance to wastewater
 - c. Chemical resistance
 - d. Dry coating thickness
 - e. Adhesion
 - f. Resistance to hot water
 - g. Resistance to temperature cycling
 6. Warranty: 10 years
 7. Manufacturers: Charlotte Pipe and Foundry, Tyler Pipe and Coupling, New Age Castings

2.5 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings:
 - 1. Standards: ASTM A888, CISPI 301.
 - 2. All cast iron soil pipe and fittings shall be 3rd party certified by CISPI or ANSI accredited third party auditing firms to the complete standards, including Annex A1.
 - 3. Manufacturers: Charlotte, Tyler, AB&I, New Age Castings
- B. Epoxy coating:
 - 1. Boring: Interior of pipe to be bored/removed for smoothness prior to coating
 - 2. Pipe and fitting interior: Minimum 5 mils
 - 3. Pipe and fitting exterior: Minimum 2.5 mils
 - 4. Epoxy touch up: Manufacturer to provide product.
 - 5. Performance Testing: 3rd party testing Per EN 877
 - a. Resistance to salt spray
 - b. Resistance to wastewater
 - c. Chemical resistance
 - d. Dry coating thickness
 - e. Adhesion
 - f. Resistance to hot water
 - g. Resistance to temperature cycling
 - 6. Warranty: 10 years
 - 7. Manufacturers: Charlotte Pipe and Foundry, Tyler Pipe and Coupling, New Age Castings
- C. CISPI, Hubless-Piping Couplings:
 - 1. Standards: ASTM C1277 and CISPI 310.
 - 2. Description: Stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
 - 3. Couplings (60 in./lbs) shall be by Anaco/Husky, Ideal Clamps, Tyler Pipe, Mission Rubber Company or approved equivalent
- D. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Standards: ASTM C1277 and ASTM C1540.
 - 2. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
 - 3. Heavy duty couplings (80 in./lbs) shall be ASTM C1540: Anaco/Husky HD-2000, Charlotte Heavy Duty 'MD', Ideal Heavy Duty, Mission HeavyWeight, Clamp-All Hi-Torque 80, MIFAB X-Hub.
- E. Extra Heavy-Duty, Hubless-Piping Couplings:
 - 1. Standards: ASTM C1277 and ASTM C1540.
 - 2. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
 - 3. Extra Heavy duty couplings (80 in./lbs) shall be ASTM C1540 with shield thickness 0.015" or greater: Anaco/Husky SD-4000 or Clamp-All Hi-Torq 125.

2.6 DUCTILE-IRON PIPE AND FITTINGS

- A. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot ends unless flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
4. Asphaltic Coating: ANSI/AWWA C151/A21.51, ANSI/AWWA C110/A21.10
5. Cement Lining: ANSI/AWWA C104/A21.4

B. Restrained joints:

1. Joints shall be restrained with EBBA Megalug, Romac Industries Romagrip, or approved equivalent. Thrust blocks or other restrains are not acceptable.

2.7 STAINLESS STEEL PIPE AND FITTINGS

- A. Stainless Steel Pipe, Plain Ends: ASTM A312/A312M plain ends, seamless; stainless steel of types and schedules as indicated in Part 3 "Piping Applications" Article.

2.8 HIGH DENSITY POLYETHYLENE

- A. Material used for the manufacture of high density polyethylene pipe and fittings shall be categorized as extra high molecular weight and meet all requirements of ASTM D33350. The high density polyethylene material shall be a cell class of PE345464C per ASTM D3350 and shall be assigned a Plastics Pipe Institute (PPI) recommended designation of PE4710. Pipe manufacturer shall be a member in good standing of the Plastic Pipe Institute.
- B. Pipe and fittings shall be manufactured from material meeting the requirements of .41. The manufacturer shall certify that samples of the manufacturer's production product have been tested in-house in accordance with ASTM D2837, and validated in accordance with the latest revision of PPI TR-3.
- C. Manufacturer shall comply with AWWA Standard C901 (1/2" through 3") and C906 (4" through 63"). The manufacturer shall comply with NSF Standard 61 and/or Standard 14 and must be certified by the NSF International for potable water. The material shall be listed by the Plastics Pipe Institute (PPI) a division of The Society of the Plastics Industry in PPI TR-4. The pipe material shall have a Hydrostatic Design Basis of 1600 psi at 73.4°F and 800 psi at 140°F. The PPI listing shall be in the name of the pipe manufacturer and testing and validation of samples of the pipe manufacturer's product shall be based upon ASTM D2837 and PPI TR-3.
- D. Referenced Standards: AWWA, C-901, AWWA C-906, ASTM D2683, ASTM D3261, ASTM D3350, PPI TR-3, PPI TR-4 and NSF Standard 61.
- E. Both pipe and fittings shall carry the same pressure rating. All fittings shall be pressure rated to match the system piping to which they are joined. AT the point of fusion, the outside diameter and minimum wall thickness of the fitting shall meet the outside diameter and minimum wall thickness specifications of ASTM F714 for the same size of pipe. All fittings shall be properly derated according to manufacturer's written recommendations, and clearly labeled on the fitting as such. Manufacturer shall have a written specification for all standard fittings which establishes Quality Control criteria and tolerances. The manufacturer of the pipe shall be the same manufacturer of

the fabricated fittings and other fabrications. The manufacturer shall certify that the materials used to manufacture pipe and fittings meet the requirements of this specification.

- F. The pipe shall have product traceability. This shall be accomplished by the inclusion of a product code into the printline of all products. This shall notate the manufacturer, the date of manufacture, the lot and supplier of raw material, the location of manufacturer, and the production shift on which the product was produced.
- G. Pipe and fittings shall be butt fusible according to the manufacturer recommended procedures. The socket or sidewall fittings shall also be to manufacturer's recommended procedures. Pipe and fittings may also be joined with flanged adapters and convoluted ductile iron rings. Mechanical fittings acceptable for use with polyethylene pipe shall follow the recommendations of the mechanical fittings manufacturer.
- H. Testing shall be in accordance with the procedure in the Plastics Pipe Institute (PPI) Technical Report TR-3.
- I. The pipe and fittings shall be PE4710 as manufactured by Isco Industries, JE Eagle, Performance Pipe or approved equivalent.

2.9 POLYETHYLENE

- A. Material used for the manufacture of high density polyethylene pipe and fittings shall be categorized as extra high molecular weight and meet all requirements for a grade PE24. The high density polyethylene material shall be a cell class of 234343E per ASTM D3350 and shall be assigned a Plastics Pipe Institute (PPI) recommended designation of PE2708 and a 60°C Hydrostatic Design Basis (HBD). Pipe manufacturer shall be a member in good standing of the Plastic Pipe Institute.
- B. Pipe and fittings shall be manufactured from material meeting the requirements of above, and all appropriate requirements of Part 192 of the Federal Minimum Safety Standards. The manufacturer shall certify that samples of the manufacturer's production product have been tested in-house in accordance with ASTM D2837, and validated in accordance with the latest revision of PPI TR-3. IPS dimensional, markings, and performance characteristics shall conform to the requirements of ASTM D2513.
- C. Both pipe and fittings shall carry the same pressure rating. All fittings shall be pressure rated to match the system piping to which they are joined. Socket type fittings shall comply with ASTM D2683. Butt fusion fittings shall comply with ASTM D3261. The manufacturer of the pipe shall be the same manufacturer of the fabricated fittings and other fabrications. The manufacturer shall certify that the materials used to manufacture pipe and fittings meet the requirements of this specification.
- D. The pipe shall have product traceability. This shall be accomplished by the inclusion of a product code into the printline of all products. This shall notate the manufacturer, the date of manufacture, the lot and supplier of raw material, the location of manufacturer, and the production shift on which the product was produced.

- E. Pipe and fittings shall be butt fusible according to the manufacturer recommended procedures. The socket or sidewall fittings shall also be to manufacturer's recommended procedures. Pipe and fittings may also be joined with flanged adapters.
- F. Testing shall be in accordance with the procedure in the Plastics Pipe Institute (PPI) Technical Report TR-3.
- G. The pipe and fittings shall be PE2708 as manufactured by Isco Industries, JE Eagle, Performance Pipe or approved equivalent.

2.10 CORRUGATED STAINLESS STEEL TUBING (CSST)

- A. Corrugated, Series 300 stainless steel tubing shall be in conformance with ASTM A 240/A 240M,
- B. Flame retardant PE coating, with surface-burning characteristics of Flame Spread Index of 25 or less and Smoke Developed Index of 50 or less, as determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- C. Where vented jacket is specified, Fully vent-capable polyethylene sleeve, creating a vented containment system for gas control safety.

2.11 FIBERGLASS PIPE AND FITTINGS

- A. RTRP: ASTM D2996, filament-wound pipe with tapered bell and spigot ends for adhesive joints.
- B. Red Thread
 - 1. ASTM D2310 Classification RTRP-11AF and 11AH
 - 2. Manufacturer of FRP piping system shall be NOV Fiber Glass Systems, Red Thread or approved equivalent.
- C. Green Thread
 - 1. ASTM D2310 Classification RTRP-11FY
 - 2. All pipe shall have a resin-rich corrosion barrier reinforced with surfacing veil. The corrosion barrier shall have a minimum resin content of 80%
 - 3. Manufacturer of FRP piping system shall be NOV Fiber Glass Systems, Green Thread or approved equivalent.
- D. Flanges: ASTM D4024; full-face gaskets suitable for the service, minimum 1/8-inch thick, 60-70 durometer. Provide ASTM A307, Grade B, hex head bolts with washers.
- E. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.12 POLYPROPYLENE PP-RCT

- A. Source Limitations: Obtain polypropylene (PP-R and PP-RCT) pipe from single manufacturer.
- B. Description: ASTM F2389; pipe pressure rating to comply with temperature and pressure ratings of code requirements for the applicable service.

1. Polypropylene Fittings: ASTM F2389, socket fusion, butt fusion, electrofusion, or fusion outlet fittings to be used for fusion-welded joints between pipe and fittings.
2. Mechanical fittings and transition fittings to be used where transitions are made to other piping materials or to valves and appurtenances.
3. Polypropylene pipe is to be unthreaded. Threaded transition fittings in accordance with ASTM F2389 to be used where a threaded connection is required.

C. Smoke and Fire Ratings:

1. Where indicated on Drawings that a plenum-rated piping system is required, the pipe is to be wrapped and/or insulated with fiberglass or mineral wool pipe insulation; field installed.
 - a. The system is to have a flame-spread classification of less than 25 and smoke-developed rating of less than 50.
 - b. Pipe, wrap, or insulation as a system to comply with the requirements of ASTM E84, or UL 2846.

2.13 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Flanges:

1. Source Limitations: Obtain dielectric flanges from single manufacturer.
2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: Per "Piping Applications" schedules.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

C. Dielectric-Flange Insulating Kits:

1. Source Limitations: Obtain dielectric-flange insulating kits from single manufacturer.
2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Gasket: Non-conductive
 - c. Bolt Sleeves: Phenolic or polyethylene.
 - d. Washers: Phenolic with steel backing washers.

D. Dielectric Nipples:

1. Source Limitations: Obtain dielectric nipples from single manufacturer.
2. Description:
 - a. Standard: IAPMO PS 66.
 - b. Electroplated steel nipple, complying with ASTM F1545.
 - c. Pressure Rating: Minimum 300 psig at 225 deg F.
 - d. End Connections: Male threaded or grooved where allowed in respective "Piping Applications" schedules.
 - e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing conditions.

3.2 PIPING APPLICATION

- A. Refer to Div 22 and Div 23 Pipe Application Schedules for service, pipe size range, joining methods per system application.

3.3 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4" ball valve, with hose end and cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce horizontal pipe sizes using eccentric reducer fitting installed with level side up.

- O. Install branch connections to mains using [mechanically formed] tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to Section 20 10 20 "Valves and Strainers".
- Q. Install air vents and pressure-relief valves in accordance with Section 232116 "Hydronic Piping Specialties."
- R. Install unions, flanges, or couplings in piping at final connections of equipment, and elsewhere as indicated.
- S. Install shutoff valve immediately upstream of each dielectric fitting.
- T. Comply with requirements in Section 20 "Common Work Results for HVAC" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
- U. Comply with requirements in Section 20 10 70 "Identification" for identifying piping.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 20 10 40 "Sleeves and Seals."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 20 10 40 "Sleeves and Seals."

3.4 JOINT CONSTRUCTION - GENERAL

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. For specialty systems and join according to pipe manufacturer's written instructions.

3.5 JOINT CONSTRUCTION - THREADED

- A. 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 pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.6 JOINT CONSTRUCTION – WELDED

- A. Welded joints shall be “V” type butt welds in accordance with ANSI B31.1.

- B. The Contractor shall only use welders regularly engaged in the piping trades and certified by the National Certified Welding Bureau, using procedures set forth in ASME Boiler Construction Code, Section IX, "Welding Qualifications".
- C. Contractor shall keep a copy of welder's certification on file at Contractor's office. Upon request the Architect/Engineer may request Contractor to produce certifications. Any pipe installed by a non-certified welder shall be removed if requested by Architect/Engineer.
- D. All steel piping shall be cleaned of mill scale and rust before assembly. Welds shall be chipped and hammered after each pass and joints shall be built up to at least the same thickness as that of the pipe wall. All welding shall be done in accordance with the welding procedures of the National Certified Pipe Welding Bureau conforming to the requirements of the ASA Code for Pressure Piping.
- E. Architect/Engineer shall have the authority to accept or reject the welds and require random samples of installed welds to be removed, tested and inspected.

3.7 JOINT CONSTRUCTION – GROOVED

- A. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
- B. Gaskets shall be suitable for the temperature, pressure and compatibility with the fluid contained therein. Unless specifically specified otherwise or incompatibility with the system, gaskets shall be EPDM grade E.
- C. Grooved couplings shall be ASTM-A47 grooved malleable iron clamp type couplings as manufactured by Victaulic or equivalent.
- D. Grooved couplings for vibration isolation or as unions at equipment connections shall be similar to Victaulic Style 77; all others shall be similar to Victaulic Style 07.

3.8 JOINT CONSTRUCTION – SOLDERED

- A. Joints for copper hydronic systems, domestic water, temperature controls, DWV systems and other applications of fluids below 250 degrees F. shall be soldered with 95-5 Tin Antimony. 50-50 Tin Lead solder shall not be used.
- B. Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
- C. Copper tubing shall be square-end cut by varied methods at the Contractor's option. The ends of the tubing shall be reamed to remove both internal and external burrs.

3.9 JOINT CONSTRUCTION – BRAZED

- A. Joints in copper piping for gases, refrigerant lines, and other applications operating above 250 degrees F., or where otherwise specified shall be brazed.
- B. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

3.10 JOINT CONSTRUCTION – FLANGED

- A. Flanges shall be flat faced or raised faced as required for mating flanges of valves, specialties, equipment connections, etc.
- B. Carbon steel hex head machine bolts, ASTM A307, grade 2, with heavy hex nuts shall be used for joining 125 and 150# flanged joints, unless otherwise specified.
- C. Alloy steel machine bolts, studs and heavy hex nuts shall be used for joining of 250 and 300# flanged joints, unless otherwise specified.
- D. Lubricate the threads of bolts and studs with an acceptable commercial product. Include data with submittal for approval for piping material.
- E. Gaskets shall be 1/16" thick non-metallic type conforming to ANSI B16.21 and shall be suitable for the pressure and temperature of the fluid contained therein, shall be provided at all flange joints. Full-faced gaskets shall be used for flat face flanges; ring gaskets shall be used for raised face flanges.

3.11 JOINT CONSTRUCTION – PLASTIC SOLVENT CEMENT

- A. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
- B. CPVC Piping: Join in accordance with ASTM D2846/D2846M Appendix.
- C. PVC Pressure Piping: Join ASTM D1785 schedule number, PVC pipe, and PVC socket fittings in accordance with ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings in accordance with ASTM D2855.
- D. PVC Nonpressure Piping: Join in accordance with ASTM D2855.
- E. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendixes.

3.12 JOINT CONSTRUCTION – CAST-IRON SOIL PIPE

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

- C. Hubless, Cast-Iron Soil Piping Coupled Joints:
- D. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

3.13 JOINT CONSTRUCTION – PE/HDPE

- A. Joints for welding in polypropylene piping shall be made in accordance with the manufacturer's instructions, by a certified contractor.
- B. No person may make a joint in a plastic pipe unless that person has been qualified. Qualifications shall be in accordance with Section 6(H) of the MPSC 4CSR240-40.030 Pipeline Safety Regulations and the Manufacturers Qualification Procedure.

3.14 JOINT CONSTRUCTION – FIBERGLASS

- A. Fiberglass-Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.
- B. FRP pipe joints shall be matched tapered bell and spigot. A manufactured approved tapering machine shall be used for field applied tapers.
- C. Adhesive shall be manufacturer's standard for piping system specified.
- D. Flanged connection gaskets shall be 1/8" thick, 60-70 durometer full face type and as approved by FRP pipe manufacturer.

3.15 JOINT CONSTRUCTION – AWWA MECHANICAL JOINTS

- A. Mechanical joints and joining material shall meet the requirements of ANSI/AWWA C111/A21.11.
- B. Clean bell and plain end, and lubricate gasket as recommended by manufacturer. The joint area must be free of dirt.
- C. All bolts and tie rods shall be galvanized. Tighten bolt to 75-90 ft.-lbs. torque alternating from top to bottom maintaining equal distance between face and gland during tightening.
- D. Where flanged joints are used to interface with equipment or other piping materials they shall be flanged joints in accordance with ANSI B16.1. The gaskets shall be full forced, made of rubber and shall meet the requirements of ANSI B16.21.

END OF SECTION 20 10 10

SECTION 20 10 20 – VALVES AND STRAINERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Ball valves
 - 2. Butterfly valves
 - 3. Balancing valves
 - 4. Check valves
 - 5. Gate valves
 - 6. Globe valves
 - 7. Wye strainers
 - 8. Basket strainers
- B. Related Requirements:
 - 1. Section 20 00 00 BASIC MECHANICAL CONDITIONS

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

1.5 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene-propylene-diene monomer.
- C. FKM: Fluoroelastomer.
- D. NBR: Nitrile butadiene rubber (also known as "Buna-N").
- E. NRS: Nonrising stem.

- F. OS&Y: Outside screw and yoke.
- G. PTFE: Polytetrafluoroethylene.
- H. RPTFE: Reinforced polytetrafluoroethylene.
- I. RS: Rising stem.
- J. SWP: Steam working pressure.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooved ends, press ends, solder ends, and weld ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
 - 4. Set butterfly valves closed or slightly open.
 - 5. Block check valves in either closed or open position.
 - 6. Set gate valves closed to prevent rattling.
 - 7. Set plug valves to open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. It is indented that valves specifications are for high quality HVAC / Plumbing applications, not lesser quality "Contractor / Value / Economy" series. Valves produced internationally shall be from the Manufacturer's owned facilities. Valves shall not be manufactured by third party OEM suppliers. Valve submittal shall indicate where the valve is assembled and tested.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded-end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.5 for flanges on steel valves.
 - 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

5. ASME B16.18 for cast-copper solder-joint connections.
 6. ASME B16.22 for wrought copper and copper-alloy solder-joint connections.
 7. ASME B16.34 for flanged- and threaded-end connections.
 8. ASME B16.51 for press joint connections.
 9. ASME B31.1 for power piping valves.
 10. ASME B31.9 for building services piping valves.
 11. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Bypass and Drain Connections: MSS SP-45.
- G. Wrench: Furnish Owner with one wrench for every [five] [10] <Insert number> plug valves, for each size square plug-valve head.
- H. Valve Actuator Type:
1. Hand Lever: For quarter-turn valves smaller than [NPS 6"] and smaller.
 2. Gear Actuator: For quarter-turn valves [NPS 8"] and larger.
 3. Where valves are located above [15'-0" AFF] provide gear operator with chain wheel and guide. Provide chain hoods where required, to prevent fouling of chains on equipment and to clear walkways. Terminate chains approximately 6'-3" above the floor.
- I. Valves in Insulated Piping
1. Provide 2-inch (50-mm) extended neck stems.
 2. Provide extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation. Ball valves T-handle: Nibco Nib-Seal, Apollo ThermaSeal, Hammond Valve Insulator/MS.
 3. Provide memory stops that are fully adjustable after insulation is applied.
- J. Only general valve series are specified. Valves shall have all options, trim, seat material, and accessories as specified whether or not listed as a prefix, suffix or valve number.

2.3 BALL VALVES

- A. Ball Valves, Threaded or Soldered Ends, 2" and smaller – Bronze, Two Piece with Full Port and Stainless Steel Trim:
1. Standard: MSS SP-110.
 2. SWP Rating: 150 psig (1035 kPa).
 3. CWP Rating: 600 psig (4140 kPa).
 4. Body Design: Two piece.
 5. Body Material: Bronze.
 6. Ends: Threaded or soldered. See pipe schedule articles.
 7. Seats: PTFE.

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8. Stem: Stainless steel.
 9. Ball: Stainless steel, vented.
 10. Port: Full.
 11. Manufacturer and models: Nibco S-585-70-66, Apollo 77-240, Watts Series B-6081, Hammond 8311 or approved equivalent. Full port valves 2 ½" and 3" the same model numbers as the 2" and smaller valves are also acceptable.
- B. Ball Valves, Threaded or Soldered Ends, 2-1/2"-3" – Bronze, Two Piece with Standard Port and Stainless Steel Trim:
1. Standard: MSS SP-110.
 2. SWP Rating: 150 psig (1035 kPa).
 3. CWP Rating: 600 psig (4140 kPa).
 4. Body Design: Two piece.
 5. Body Material: Bronze.
 6. Ends: Threaded or soldered. See pipe schedule articles.
 7. Seats: PTFE.
 8. Stem: Stainless steel.
 9. Ball: Stainless steel, vented.
 10. Port: Standard.
 11. Manufacturer and models: Nibco S-585-66, Apollo 70-240, Watts Series B-6001, Hammond 8511 or approved equivalent. Full port valves 2 ½" and 3" the same model numbers as the 2" and smaller valves are also acceptable.
- C. Ball Valves, Threaded Ends, 2-1/2" and smaller – Bronze, Three Piece with Full Port and Stainless Steel Trim:
1. Standard: MSS SP-110.
 2. SWP Rating: 150 psig (1035 kPa).
 3. CWP Rating: 600 psig (4140 kPa).
 4. Body Design: Three piece.
 5. Body Material: Bronze.
 6. Ends: Threaded.
 7. Seats: PTFE.
 8. Stem: Stainless steel.
 9. Ball: Stainless steel, vented.
 10. Port: Full.
 11. Manufacturer and models: NIBCO figure 595-Y-66, Apollo 82-200, Milwaukee BA-360, Hammond 8613, Watts B-6800, or approved equivalent. Full port valves 2 ½" and 3" the same model numbers as the 2" and smaller valves are also acceptable.
- D. Ball Valves, Flanged Ends - Iron, Class 125:
1. Standard: MSS SP-72.
 2. CWP Rating: 200 psig (1380 kPa).
 3. Body Design: Split body.
 4. Body Material: ASTM A126, gray iron.
 5. Ends: Flanged.
 6. Seats: PTFE.
 7. Stem: Stainless steel.
 8. Ball: Stainless steel.
 9. Port: Full.
 10. Manufacturer and models:
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- E. Ball Valves, Flanged Ends - Steel, with Full Port and Stainless Steel Trim, Class 150:
1. Standard: MSS SP-72.
 2. CWP Rating: 285 psig (1964 kPa).
 3. Body Design: Split body.
 4. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
 5. Ends: Flanged.
 6. Seats: PTFE.
 7. Stem: Stainless steel.
 8. Ball: Stainless steel, vented.
 9. Port: Full.
 10. Manufacturer and models:
- F. Ball Valves, Flanged Ends - Steel, with Full Port and Stainless Steel Trim, Class 300:
1. Standard: MSS SP-72.
 2. CWP Rating: 720 psig (4960 kPa).
 3. Body Design: Split body.
 4. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
 5. Ends: Flanged.
 6. Seats: PTFE.
 7. Stem: Stainless steel.
 8. Ball: Stainless steel, vented.
 9. Port: Full.
 10. Manufacturer and models:
- G. Ball Valves - CPVC, Union Type:
1. Standard: MSS SP-122.
 2. Pressure Rating and Temperature: 125 psig (860 kPa), 150 psig (1035 kPa), or other pressure at 73 deg F (23 deg C) or other temperature. See Part 3 ball valve schedule articles.
 3. Body Material: CPVC.
 4. Body Design: Union type.
 5. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 ball valve schedule articles.
 6. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable socket, socket or threaded, threaded, or flanged. See Part 3 ball valve schedule articles.
 7. Ball: CPVC; full port.
 8. Seals: PTFE or EPDM-rubber O-rings.
 9. Handle: Tee shaped.
 10. Manufacturer and models:
- H. Ball Valves - CPVC, Non-Union Type:
1. Standard: MSS SP-122.
 2. Pressure Rating and Temperature: 125 psig (860 kPa), 150 psig (1035 kPa), or other pressure at 73 deg F (23 deg C) or other temperature. See Part 3 ball valve schedule articles.
 3. Body Material: CPVC.
 4. Body Design: Non-union type.
 5. End Connections: Socket or threaded.
 6. Ball: CPVC; full or reduced port.
 7. Seals: PTFE or EPDM-rubber O-rings.
 8. Handle: Tee shaped.
 9. Manufacturer and models:
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2.4 BUTTERFLY VALVES

- A. Butterfly Valves, Single Flange (Lug Type) – Ductile Iron, with Aluminum-Bronze Disc:
1. Standard: MSS SP-67, Type I, API-609, Type A
 2. CWP Rating: 200 psig 12” and smaller, 150 psig 14” and larger
 3. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange. Integrally cast top plate for direct flush mounting of manual or power actuators without the use of brackets or adapters.
 4. Body Material: ASTM A536, ductile iron.
 5. Seat & Stem seals: Peroxide cured EPDM molded-in seat liner
 - a. Valves shall be chemically compatible with: up to 4ppm of Chloramines (NH₂Cl, NHCl₂, NCl₃) 40°F-200°F, propylene glycol 0°F-200°F; and NSF-61 rated 40°F-180°F.
 - b. Where used in potable water valve shall be “lead free” per 2011 Reduction of Lead in Drinking Water Act.
 6. Stem: One- or two-piece stainless steel.
 7. Disc: Aluminum bronze.
 8. Manufacturer and models: NIBCO figure LD 2000, Milwaukee ML-133E, Hammond 6411, Bray 31H, Apollo LD-145, Watts DBF-03, or approved equivalent. The following valves are NOT equivalent NIBCO N200, Milwaukee CL series, Hammond 5000 series, Apollo LC series, Watts BF series, or Crane 200 series.
- B. Butterfly Valves, Single Flange (Lug Type) - High Performance, Class 150:
1. Standard: MSS SP-68, API-609, Type B
 2. CWP Rating: 285 psig (1965 kPa) at 100 deg F (38 deg C).
 3. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 4. Body Material: Carbon or stainless steel. See Part 3 butterfly valve schedule articles.
 5. Seat: Reinforced PTFE or metal.
 6. Stem: Stainless steel; offset from seat plane.
 7. Disc: Type 316 stainless steel.
 8. Service: Bidirectional.
 9. Manufacturer and model NIBCO

2.5 BALANCE VALVES

- A. Balance valves shall provide positive shut-off for service and shall have adjustable memory stops to allow returning to original balanced position after servicing.
- B. Balance Valves, Threaded or Soldered Ends, 3” and smaller:
1. Design: Valves shall be multi-turn, fixed orifice, provide positive shut off, position indication, memory stops, integral pressure tap ports provided with “drip caps”. Quarter turn valves are not acceptable.
 2. CWP Rating: 300 psig.
 3. Body Material: ASTM B62, bronze, or dezincification resistant brass
 4. Ends: Threaded or soldered. See pipe schedule articles.
 5. Stem: Bronze.
 6. Disc: PTFE.
 7. Packing: Asbestos free.
 8. Handwheel: Polymer.

9. Manufacturer and models: Nibco 1810, Tour and Anderson 786/787, Apollo 59A, Armstrong CBV, Macon Balancing STV/L Series or approved equivalent.
- C. Balance Valves, Flanged Ends, 4"-12" - Iron, Class 150:
 1. Design: Valves shall be multi-turn, fixed orifice, provide positive shut off, position indication, memory stops, integral pressure tap ports provided with "drip caps". Quarter turn valves are not acceptable.
 2. CWP Rating: 200 psig.
 3. Body Material: ASTM A536, ductile iron.
 4. Ends: Threaded or soldered.
 5. Stem: Bronze.
 6. Disc: PTFE.
 7. Packing: Asbestos free.
 8. Handwheel: Polymer.
 9. Manufacturer and models: Nibco F739, Tour & Anderson 788, Apollo 58A, Armstrong CBV, Macon Balancing STV, Watts CSM-91, or approved equivalent.
- D. Balance Valves, Flanged Ends, 14"-24"
 1. Balance valves shall be butterfly valves with memory stop. Where valve is used in conjunction with balancing a specific piece of equipment (and not general throttling in order to assist in balancing) it shall be used in conjunction with a flow-measuring device.

2.6 GATE VALVES

- A. Gate Valves, Threaded or Soldered Ends - Bronze, RS, Class 125:
 1. Standard: MSS SP-80, Type 2.
 2. CWP Rating: 200 psig (1380 kPa).
 3. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 4. Ends: Threaded or soldered. See pipe schedule articles.
 5. Stem: Bronze.
 6. Disc: Solid wedge; bronze.
 7. Packing: Asbestos free.
 8. Handwheel: Malleable iron
 9. Manufacturer and models: Nibco 111, Grinnell 3010, Milwaukee 148, Hammond IB640, Watts 3100, Stockham B100, or approved equivalent.
- B. Bronze Gate Valves, RS, Class 150:
 1. Standard: MSS SP-80, Type 2.
 2. CWP Rating: 300 psi.
 3. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 4. Ends: Threaded.
 5. Stem: Bronze.
 6. Disc: Solid wedge; bronze.
 7. Packing: Asbestos free.
 8. Handwheel: Malleable iron
 9. Manufacturer and models: Nibco T-134, or approved equivalent.
- C. Iron Gate Valves, OS&Y, Class 125:
 1. Standard: MSS SP-70, Type I.
 2. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.

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3. NPS 14 to NPS 24, CWP Rating: 150 psig.
 4. Body Material: ASTM A126, gray iron with bolted bonnet.
 5. Ends: Flanged.
 6. Trim: Bronze.
 7. Disc: Solid wedge.
 8. Packing and Gasket: Asbestos free.
 9. Handwheel: Cast iron
 10. Manufacturer and models: Nibco F-617, Grinnell 6020, Milwaukee F-2885, Hammond IR1140, Watts F503, Stockham 6623, or approved equivalent.
- D. Bronze Gate Valves, RS, Class 200:
1. Standard: MSS SP-80, Type 2.
 2. CWP Rating: 400 psi.
 3. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 4. Ends: Threaded.
 5. Stem: Bronze.
 6. Disc: Solid wedge; bronze.
 7. Packing: Asbestos free.
 8. Handwheel: Malleable iron
 9. Manufacturer and models: Nibco T-154-A, or approved equivalent.
- E. Bronze Gate Valves, RS, Class 300:
1. Standard: MSS SP-80, Type 2.
 2. CWP Rating: 600 psi.
 3. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 4. Ends: Threaded.
 5. Stem: Bronze.
 6. Disc: Solid wedge; bronze.
 7. Packing: Asbestos free.
 8. Handwheel: Malleable iron
 9. Manufacturer and models: Nibco T-174SS, Watts B-3030-BS, Stockham B145, Milwaukee 1184, Crane 424, or approved equivalent.
- F. Iron Gate Valves, OS&Y, Class 250:
1. Standard: MSS SP-70, Type I.
 2. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 3. NPS 14 to NPS 24, CWP Rating: 300 psig.
 4. Body Material: ASTM A126, gray iron with bolted bonnet.
 5. Ends: Flanged.
 6. Trim: Bronze.
 7. Disc: Solid wedge.
 8. Packing and Gasket: Asbestos free.
 9. Manufacturer and models: Nibco F-667, Stockham F-667, Milwaukee F2894, Crane 7-1/2E, or approved equivalent
- G. Steel Gate Valves, OS&Y, Class 150:
1. Standard: API 600, ASME 16.34
 2. NPS 2-1/2 to NPS 24, CWP Rating: 285 psig.
 3. Body Material: ASTM A216 Gr WCB, cast carbon steel with bolted bonnet.
 4. Ends: Flanged.
 5. Trim: API trim 8.
-

6. Disc: Flexible wedge.
 7. Packing and Gasket: Asbestos free.
 8. Handwheel: Steel
 9. Manufacturer and models: Powell Figure 1503, Hancock 600, or approved equivalent.
- H. Steel Gate Valves, OS&Y, Class 300:
1. Standard: API 600, ASME 16.34
 2. NPS 2-1/2 to NPS 24, CWP Rating: 740 psig.
 3. Body Material: ASTM A216 Gr WCB, cast carbon steel with bolted bonnet.
 4. Ends: Flanged.
 5. Trim: API trim 8.
 6. Disc: Flexible wedge.
 7. Packing and Gasket: Asbestos free.
 8. Manufacturer and models: Powell Figure 3003, Hancock 600, or approved equivalent.
- I. Epoxy Coated, Ductile Iron, Resilient Wedge, NRS, 300 CWP
1. Standard: AAWA C509
 2. Listings: UL 262 listed, FM 1120/1130 approved, NSF 61
 3. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
 4. NPS 14 to NPS 48, CWP Rating: 250 psig.
 5. Body Material: ASTM A536 ductile iron with bolted bonnet.
 6. Coating: Epoxy exceeding ANSI/AWWA C550
 7. Ends: Per Pipe schedule
 8. Trim: Bronze
 9. Disc: ASTM A536 ductile iron with peroxide cured EDPM
 10. Packing and Gasket: Asbestos free.
 11. Performance: Valves shall be "lead free" per 2011 Reduction of Lead in Drinking Water Act. Valves shall be chemically compatible with: up to 4ppm of Chloramines (NH₂Cl, NHCl₂, NCl₃) 40°F-160°F and NSF-61 rated 40°F-160°F.
 12. Manufacturer and models: Nibco F-619-RW, Mueller A-2362 thru 12 NPS, Mueller A-2361 14-48 NPS, or approved equivalent

2.7 CHECK VALVES

- A. Check Valves, Swing Type, Threaded Ends - Bronze, with Bronze Disc, Class 125:
1. Standard: MSS SP-80, Type 3.
 2. CWP Rating: 200 psig.
 3. Body Design: Horizontal flow, vertical up-flow
 4. Body Material: ASTM B62, bronze.
 5. Ends: Threaded.
 6. Disc: Bronze.
 7. Manufacturer and models: Nibco 413, Grinnell 3300, Watts 5000, Crane 1707, Hammond IB904, Stockham B320, or approved equivalent.
- B. Check Valves, Swing Type, Flanged Ends - Iron, with Metal Seats, Class 125:
1. Standard: MSS SP-71, Type I.
 2. CWP Rating, NPS 2-1/2 to NPS 12: 200 psig.
 3. CWP Rating, NPS 14 to NPS 24: 150 psig.
 4. Body Design: Clear or full waterway.
 5. Body Material: ASTM A126, gray iron with bolted bonnet.

6. Ends: Flanged.
 7. Trim: Bronze.
 8. Gasket: Asbestos free.
 9. Manufacturer and models: Nibco 918, Grinnell 6300A, Watts 511, Crane 373, Hammond IR1124, Jenkins 624C, Stockham G931, or approved equivalent.
- C. Check Valves, Inline Spring Type, Threaded Ends - Bronze, with Bronze Disc, Class 125:
1. Standard: MSS SP-80, Type 3.
 2. CWP Rating: 200 psig.
 3. Body Design: Inline spring check, all flow directions.
 4. Body Material: ASTM B62, bronze.
 5. Ends: Threaded.
 6. Disc: Bronze.
 7. Manufacturer and models: Nibco H-1074W series, Apollo 61 Series, Watts LF600
- D. Check Valves, Swing Type, Threaded Ends - Bronze, with Bronze Disc, Class 300:
1. Standard: MSS SP-80, Type 3.
 2. CWP Rating: 600 psig.
 3. Body Design: Horizontal flow, vertical up-flow
 4. Body Material: ASTM B62, bronze.
 5. Ends: Threaded.
 6. Disc: Bronze.
 7. Manufacturer and models: Nibco T-473, Grinnell 3370, Milwaukee 507, Hammond IB949, or approved equivalent.
- E. Check Valves, Swing Type, Flanged Ends - Iron, with Metal Seats, Class 250:
1. Standard: MSS SP-71, Type I.
 2. CWP Rating, NPS 2-1/2 to NPS 12: 500 psig.
 3. CWP Rating, NPS 14 to NPS 24: 300 psig.
 4. Body Design: Clear or full waterway.
 5. Body Material: ASTM A126, gray iron with bolted bonnet.
 6. Ends: Flanged.
 7. Trim: Bronze.
 8. Gasket: Asbestos free.
 9. Manufacturer and models:
- F. Silent Check Valves, Center Guided - Iron, Globe, with Metal Seat, Class 125:
1. Standard: MSS SP-125.
 2. CWP Rating, NPS 2-1/2 to NPS 12: 200 psig.
 3. CWP Rating, NPS 14 to NPS 24: 150 psig.
 4. Body Material: ASTM A126, gray iron.
 5. Style: Globe, spring loaded.
 6. Ends: Flanged.
 7. Seat: Bronze.
 8. Manufacturer and models: Nibco F-910, Grinnell Series 500, Milwaukee 125 Class, Mueller 91-AP, or approved equivalent.
- G. Silent Check Valves, Center Guided - Iron, Globe, with Metal Seat, Class 250:
1. Standard: MSS SP-125.
 2. CWP Rating, NPS 2-1/2 to NPS 12: 400 psig.
 3. CWP Rating, NPS 14 to NPS 24: 300 psig.

4. Body Material: ASTM A126, gray iron.
5. Style: Globe, spring loaded.
6. Ends: Flanged.
7. Seat: Bronze.
8. Manufacturer and models: Nibco F-960, Grinnell Series 550, Milwaukee 250 Class, or approved equivalent.

H. Check Valves - CPVC, Union-Type Ball Check:

1. Body Material: CPVC.
2. Body Design: Union-type ball check.
3. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded. See Part 3 check valve schedule articles.
4. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket, socket or threaded, threaded, flanged. See Part 3 check valve schedule articles.
5. Ball: CPVC.
6. Seals: EPDM- or FKM-rubber O-rings.
7. Manufacturer and models:

2.8 WYE STRAINER

A. Bronze Y-Pattern Strainers, class 125

1. Body: ASTM C87850 Lead free Bronze with threaded cover and bottom drain connection.
2. CWP Rating: 200 psig.
3. End Connections: Threaded ends for NPS 3 and smaller
4. Strainer Screen: Stainless steel, mesh strainer, or perforated stainless steel basket.
 - a. Water: 20 mesh
 - b. Steam: 30 mesh
5. Manufacturer and models: Mueller 351M, Keckley F-150, Watts 777/777S, Nibco T-221/222-A, Armstrong F4SC, Spirax/Sarco BT, or approved equivalent.

B. Cast iron Y-Pattern Strainers, class 125

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. CWP Rating, NPS 1/2 to NPS 12: 200 psig.
3. CWP Rating, NPS 14 to NPS 24: 150 psig.
4. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
5. Strainer Screen: Stainless steel, mesh strainer, or perforated stainless steel basket.
 - a. Water: 1/8 inch
 - b. Steam: 3/64 inch
6. Manufacturer and models: Mueller 751, Keckley A, Watts 77F-D, Nibco T-751-A / F-721-A, Armstrong A-FL-125, Spirax/Sarco F-125, Watts 77F-D, or approved equivalent.

C. Bronze Y-Pattern Strainers, class 250

1. Body: ASTM C87850 Lead free Bronze with threaded cover and bottom drain connection.
2. CWP Rating: 400 psig.
3. End Connections: Threaded ends for NPS 3 and smaller
4. Strainer Screen: Stainless steel, mesh strainer, or perforated stainless steel basket.
 - a. Water: 20 mesh
 - b. Steam: 30 mesh

5. Manufacturer and models: Mueller 352M, Keckley F-350, Armstrong F4SC, Spirax/Sarco BT, or approved equivalent.
- D. Cast iron Y-Pattern Strainers, class 250
1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
 2. CWP Rating: 400 psig.
 3. End Connections: Threaded ends for NPS 2 and smaller
 4. Strainer Screen: Stainless steel, mesh strainer, or perforated stainless steel basket.
 - a. Water: 20 mesh
 - b. Steam: 30 mesh
 5. Manufacturer and models: Mueller 11-M, Keckley B, Armstrong A-SC, Spirax/Sarco IT, or approved equivalent.
- E. Cast iron Y-Pattern Strainers, class 250
1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
 2. CWP Rating, NPS 2-1/2 to NPS 12: 400 psig.
 3. CWP Rating, NPS 14 to NPS 24: 150 psig.
 4. End Connections: Threaded ends for NPS 2 and smaller
 5. Strainer Screen: Stainless steel, mesh strainer, or perforated stainless steel basket.
 - a. Water: 1/8 inch
 - b. Steam: 3/64 inch
 6. Manufacturer and models: Mueller 752, Keckley A, Armstrong A-FL-250, Spirax/Sarco F-250, Watts 77F-D-250, or approved equivalent.

2.9 BASKET STRAINER

- A. Cast Iron, class 125
1. Body: ASTM A126, Class B, high-tensile cast iron with quick open cover and bottom drain connection.
 2. CWP Rating, NPS 2-1/2 to NPS 12: 200 psig.
 3. CWP Rating, NPS 14 to NPS 24: 150 psig.
 4. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 5. Strainer Screen: 40 mesh startup strainer and 1/8 inch perforated stainless steel basket with 50 percent free area.
 6. Manufacturer and models: Mueller 125F-CI, Keckley, Titan Flow Control, or approved equivalent.
- B. Stainless Steel Fabricated, class 125
1. Body: Stainless steel with quick open cover and bottom drain connection.
 2. CWP Rating, NPS 4 to NPS 12: 200 psig.
 3. CWP Rating, NPS 14 to NPS 36: 150 psig.
 4. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 5. Strainer Screen: 40 mesh startup strainer and 1/8 inch perforated stainless steel basket with 50 percent free area.
 6. Manufacturer and models: Mueller 185 FAB-Q, Keckley, Titan Flow Control or approved equivalent.
- C. Cast Carbon Steel, class 300

1. Body: ASTM A216 Gr WCB with quick open cover and bottom drain connection.
2. CWP Rating, NPS 2-1/2 to NPS 18: 740 psig.
3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. Strainer Screen: 40 mesh startup strainer and 1/8 inch perforated stainless steel basket with 50 percent free area.
5. Manufacturer and models: Mueller 126F-CS, Keckley, Titan Flow Control, or approved equivalent.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

3.2 VALVE APPLICATION

- A. Refer to Div 22 and Div 23 Pipe Application Schedules for valves types, size ranges, material, and end connection per system application.
- B. Gauge cocks where not specified or specifically identified shall be 1/4" bronze 2 piece body ball valves with lever handle and threaded ends per the above specification.
- C. Drain valves and air vents shall be 3/4" bronze 2 piece body ball valves per the above specification, with 3/4" hose end adapter cap and chain. In 1/2" through 2" pipe, contractor may use Webstone model T-drain.

3.3 INSTALLATION OF VALVES

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Provide support of piping adjacent to valves such that no force is imposed upon valves.
- C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

- D. For valves in horizontal piping, install valves with stem at or above center of pipe.
- E. Install valves in position that does not project into aisles or block access to other equipment.
- F. Install valves in position to allow full stem and actuator or manual operator movement.
- G. Verify that joints of each valve have been properly installed and sealed to ensure that there is no leakage or damage.
- H. Install check valves for proper direction of flow and as follows:
 - 1. Check Valves: Center-guided type in horizontal or vertical position, between flanges.
 - 2. Check Valves, Swing Type: In horizontal position with hinge pin level.
 - 3. Check Valves, Lift Type: With stem upright and plumb.
- I. Valve Tags: Comply with requirements for valve tags and schedules in Section 20 10 70 "Identification."
- J. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve of manufacturer's written recommended maximum.

3.4 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 20 10 20

SECTION 20 10 30 – HANGERS, SHIELDS, SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems (Unistrut).
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Equipment stands.
 - 8. Equipment supports.
- B. Related Requirements:
 - 1. Section 20 00 00 BASIC MECHANICAL CONDITIONS

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Equipment supports.
 - 2. Pipe Racks.

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic per Section 20 05 48 Vibration and Seismic Controls.
- B. Good Manufacturing Practices (GMP) hygienic design in food-grade or pharmaceutical spaces identified on the plans.

2.2 MANUFACTURERS

- A. Acceptable manufacturers of hanger products that comply with the specifications.
 - 1. Anvil (ASC Engineered Solution)
 - 2. Eaton B-Line Systems
 - 3. Tolco
 - 4. PHD Manufacturing
 - 5. National Pipe Hanger Corp

2.3 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Beam Clamps and devices used to attach to structure:

2.4 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
 - 3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
- B. Stainless Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
- C. Copper Pipe and Tube Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.

2.5 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.6 MANUFACTURED METAL FRAMING SYSTEMS (UNISTRUT)

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
 - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 3. Channels: Continuous slotted carbon-steel, stainless steel, Type 304, stainless steel, Type 316, extruded-aluminum channel with inturned lips.
 - 4. Channel Width: Selected for applicable load criteria.
 - 5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

6. Metallic Coating: Pregalvanized G90 (Z275), Electroplated zinc or Gold (yellow zinc dichromate) galvanized., Hot-dip galvanized.
7. Paint Coating: Green epoxy, acrylic, or urethane

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing conditions....

3.2 APPLICATION

- A. 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 lbs.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation: Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Pipe Stand Installation:
 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic 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.

- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping:
 - 1. Use thermal-hanger shield insert with pipe hanger / clamp sized to match OD of insert.
 - 2. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 3. Install MSS SP-58, Type 40, protective shields. Shields shall span an arc of 180 degrees.
 - 4. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 5. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - f. Pipes NPS 8 and Larger: Include insulation inserts per Section 20 20 25 "Insulation" of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.4 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place 1" minimum grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.5 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- 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/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.6 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 a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches maximum.

3.8 HANGER AND SUPPORT SCHEDULE

- A. Specialty hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- E. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- F. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
- G. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

- H. Use padded hangers for un-insulated piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Singular, horizontal, suspended piping above grade shall be hung with pipe hangers sized for the outside diameter of the insulation per the following schedule, unless noted otherwise:
 - 1. Systems without anchors and guides for expansion control
 - a. NPS 3 inch and smaller: Adjustable ring, Figure 69
 - b. NPS 4 inch and larger: Adjustable clevis, Figure 260
 - 2. Systems with anchors and guides for expansion control
 - a. All sizes: Adjustable steel yoke Figure 182 with protection saddle Figure 160 thru 165.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel piping: Figure 261
 - 2. Copper piping: Figure CT-261
- L. Finish shall per location and environment.
 - 1. Indoor, dry, non-corrosive: Cadmium or zinc electro-plated
 - 2. Indoor, wet or damp: Hot dipped galvanized
 - 3. Indoor corrosive: [304] [316] Stainless steel
 - 4. Outdoor: Hot dipped galvanized

END OF SECTION 20 10 30

SECTION 20 10 40 – SLEEVES AND SEALS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves without waterstop.
 - 2. Sleeves with waterstop.
 - 3. Stack-sleeve fittings.
 - 4. Sleeve-seal systems.
 - 5. Grout.
 - 6. Silicone sealants.
 - 7. Escutcheons.
- B. Related Requirements:
 - 1. Section 20 00 00 BASIC MECHANICAL CONDITIONS

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES WITHOUT WATERSTOP

- A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends.
- B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
- C. Steel Sheet Sleeves: ASTM A653/A653M, 0.0239-inch minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
- D. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
- E. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 SLEEVES WITH WATERSTOP

- A. Molded HDPE with integral waterstop, furnish with nailer end caps.
- B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, 2" steel collar, welded on both sides, hot-dip galvanized, with plain ends.

2.3 MODULAR LINK-SEAL SYSTEMS

- A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Designed to form a hydrostatic seal of 20 psig minimum.
 - 2. Sealing Elements: Material as indicated below, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - a. Normal, except noted below: EPDM-rubber
 - b. Steam and other service temperatures between 200°F-450°F: High-temperature-silicone
 - c. Non-metallic piping: Low Durometer EPDM, Shore 40 ± 5
 - 3. Pressure Plates: Reinforced Nylon Polymer.
 - 4. Connecting Bolts and Nuts: Stainless steel, Type 316 of length required to secure pressure plates to sealing elements.
- B. Sleeves and seals manufactured by Garlock-LINK-SEAL, Flexicraft Industries, Advance Products & Systems, Metraflex, or approved equivalent.

2.4 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000 psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealant, S, P, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant. b. Standard: ASTM C920.

2.6 ESCUTCHEONS

- A. Escutcheon Types:
 - 1. One-Piece, Stainless Steel Type: With polished stainless steel finish.
 - 2. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing conditions for partition types and execute work per the requirements herein.

3.2 INSTALLATION OF SLEEVES AND CORE DRILLING - GENERAL

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes, except where noted. Prior to core drilling structure shall be scanned with X-ray, Redar, or other means to locate rebar and verify that conduit/pipes are not imbedded in the concrete, Submit scans with an overlay of the proposed core drills for approval.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [2 inches (50 mm)] <Insert dimension> above finished floor level.
 - 3. Using [grout] [or] [silicone sealant], seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."
- F. Acoustical

3.3 INSTALLATION OF SLEEVES WITH WATER STOP

- A. Install sleeve with water stop as new walls and slabs are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.

3.4 INSTALLATION OF LINK-SEAL SYSTEMS

- A. Install link-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.
 - 1. Locate the bolts in accessible position to allow tightening.

3.5 SLEEVE SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. New Exterior Concrete Walls below Grade:
 - a. Link seal system. Molded HDPE sleeves with water stops.
 - 2. New Exterior Concrete Walls above Grade:
 - 3.
 - 4. Existing Exterior Concrete Walls below Grade:
 - a. Link seal system. Core drilled hole
 - 5. Existing Exterior Concrete Walls above Grade:
 - a.
 - 6. New Concrete Slabs-on-Grade:
 - a. Sleeves with water stops.
 - 1) Select sleeve size to allow for 2-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 7. Existing Concrete Slabs-on-Grade:
 - a. Sleeves with water stops.
 - 1) No Sleeve: Core drill to allow for 2-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 8. New Concrete Slabs above Grade:
 - a. Mechanical rooms and wet areas: Sleeves with water stops
 - b. Dry areas: Molded Sleeve
 - 9. Existing Concrete Slabs above Grade:
 - a. Mechanical rooms and wet areas: [Sleeves with water stops] [or] [stack-sleeve fittings].
 - b. Dry areas: Core Drill
 - 10. Interior Partitions:
 - a. Masonry: Sheet steel
 - b. Drywall: neatly field cut round holes with hole saws

3.6 INSTALLATION OF ESCUTCHEONS

- A. Install escutcheons for piping penetrations of finished walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
- C. Use one-piece escutcheons for all sizes available on new piping. Use spit type on existing piping and large piping where one-piece not available.

END OF SECTION 20 10 40

SECTION 20 10 50 – BASIC MECHANICAL METHODS - RELATED WORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Demolition
 - 2. Cutting and Patching
 - 3. Excavation, Trenching, and Backfilling
 - 4. Concrete Work
 - 5. Painting
 - 6. Lubrication
 - 7. Draining, Filling, and Venting Systems
- B. Related Requirements:
 - 1. Section 20 00 00 BASIC MECHANICAL CONDITIONS

1.2 ACTION SUBMITTALS

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

1.3 SHOP DRAWINGS

- A. Detailed and dimensioned drawings of size, location, reinforcing and hardware contained therein of concrete work to be provided.

1.4 INFORMATIONAL SUBMITTALS

- A. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include: name, license number, and address of technician; date refrigerant was recovered; the machine and serial number of the reclaim equipment used, type and quantity of reclaimed refrigerant, and all other required data.

1.5 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.6 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

1.7 DEMOLITION

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Coordinate with Owner for shut off of private utility of indicated services/systems.
 - 2. Arrange to shut off public utilities with utility companies.
 - 3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - c. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - d. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - e. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - 4. Were indicated on the drawings to abandon in place.
 - a. Piping to Be Abandoned in Place: Drain piping, disconnect at the points indicated, and cap or plug piping with same or compatible piping material and leave in place.
 - b. Ducts to Be Abandoned in Place: Disconnect at the points indicated, cap or plug ducts with same or compatible ductwork material and leave in place.
 - c. Underground Piping to Be Abandoned in Place: Drain piping, disconnect at the points indicated, and fill abandoned piping with hydraulic cement.
 - 5. Dead legs of branch piping are not permitted unless a cap is specifically shown on the drawings. Where a cap is not shown and the drawings indicate to cap piping, the Contractor shall remove branch piping back to the main and cap at that point.

1.8 CUTTING AND PATCHING

- A. The basic premise of this Sub-section is that the cutting and patching (where required) are performed in existing building components. In “new” construction, the premise is that the building component is already in place.
- B. The Contractor requiring the penetration of or the access way in the building structure to fulfill the intent of the Project Documents for his Work shall be responsible for the cutting and the subsequent patching in accordance with the following criteria:
 - 1. No structural component of the building shall be cut or violated without express approval of the Architect/Engineer.

- 2. The Contractor shall verify the presence of any concealed utility or service within the structure (walls, roof, floor, etc.) in question, and shall be responsible for maintaining continuity and/or replacing it.
- C. Cutting of work-in-place in “new” construction because of error, neglect or damage inflicted shall be the responsibility of the Contractor precipitating the issue.
- D. “Patching” shall be construed as the repairing or replacing of the building structure to return it to an original or new condition, in the opinion of the Owner and/or Architect/Engineer, as existed prior to the cutting.
- E. Patching and finishing work shall be the responsibility of the Contractor requiring the cutting. The patching shall match all the substantive and visual aspects of the structure and adjacent surfaces. Restoration and finishes shall be as specified and executed in the respective sections, schedules and/or details of the Project Documents for the general construction work. Completed work and any special requirements shall be subject to approval by and satisfaction of the Architect/Engineer.

1.9 DRAINING, FILLING AND VENTING SYSTEMS

- A. The Contractor shall provide all required labor for draining, filling and venting of new **[or modified]** systems as many times as required during construction **[and for all phasing activities]**.
- B. Where draining and filling systems affects other systems or the Owner’s normal operations, then they shall be scheduled at least 24 hours in advance with the Owner and shall be carried out to minimize such disruptions.

1.10 LUBRICATION

- A. Provide all oil and grease for the operation of all equipment until acceptance. The Mechanical Contractor and Subcontractors shall be held responsible for all damage to bearing while the equipment is being operated by them up to the date of acceptance of the equipment. Protect all bearings during installation and thoroughly grease steel shafts and other unpainted steel surfaces to prevent corrosion. All motors and other equipment shall be provided with covers as required for proper protection during construction. For equipment that is received void (dry) of lubrication the Contractor shall lubricate the equipment before storing to prevent internal damage to the equipment.
- B. [After the Contractor moves on site, they shall hand rotate all existing rotating equipment at least once every week in order to make sure the equipment remains free and eliminate the risk of including a permanent set in the rotating shaft or bearing. Equipment that requires more frequency or special treatment in rotating procedures shall be handled as specified _____.]

1.11 CONCRETE WORK (CAST-IN-PLACE)

- A. General:
 - 1. This sub-section shall supplement Section 03300 – Concrete Work for the concrete work required to install the work of Divisions 20 - 25.

2. In the event of a conflict between this sub-section and Section 03300, the more stringent shall apply.
- B. Provide concrete foundations, bases and/or housekeeping pads for mechanical equipment furnished in his respective scope of work where such are not indicated on the architectural or structural drawings. Concrete work shall include requisite excavation, formwork, reinforcing and contained hardware.
- C. Housekeeping Pads:
 1. All equipment setting on concrete or other type of pave flooring shall be set upon a raised "housekeeping" pad, unless noted otherwise.
 2. The Contractor shall be responsible for this size, location, and any required anchor bolts. In general, housekeeping pads shall be a minimum of 3 ½" high, a ¾" chamfer on exposed corners and edges, and a minimum of 3" beyond the equipment on all sides or as required for anchor bolt edge distance.
 3. Housekeeping pads shall be 3000 psi 28-day compressive strength concrete. Pads shall be reinforced and doweled to the floor slab. Refer to ASHRAE-A Practical Guide to Seismic Restraint 1999, Chapter 6 – Housekeeping Pads for size and spacing of reinforcing and dowels.
- D. Thrust Blocks:
 1. Thrust blocks shall be installed at all changes in direction and end points in unrestrained underground pressure piping systems and where required by installation standards, or manufactures instructions.
 2. Thrust blocks shall only contact the backside of the fittings and shall not cover any joints. All thrust blocks will be inspected by the Owner's Representative prior to backfilling, provide a minimum of 3 days' notice.

END OF SECTION 20 10 50

SECTION 20 10 60 – TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Testing, Adjusting, and Balancing of Air Systems:
 - 2. Testing, Adjusting, and Balancing of Hydronic Piping Systems:
 - 3. Testing, Adjusting, and Balancing of Domestic Water Systems:
 - 4. Testing, adjusting, and balancing of fuel oil systems for HVAC.
 - 5. Testing, adjusting, and balancing of steam and condensate piping systems.
 - 6. Testing, adjusting, and balancing of equipment.
 - 7. Testing, adjusting, and balancing of existing HVAC systems and equipment prior to modification.
 - 8. Procedures for exhaust hoods.
 - 9. Sound tests.
 - 10. Vibration tests.
 - 11. Duct leakage tests verification.
 - 12. Pipe leakage tests verification.
 - 13. UFAD plenum leakage tests verification.
 - 14. HVAC-control system verification.
 - 15. Smoke-control system tests.
- B. Related Requirements:
 - 1. Section 20 00 00 BASIC MECHANICAL CONDITIONS

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.
- G. UFAD: Underfloor air distribution.

1.3 REFERENCES

- A. National Standards for Total System Balance, by the Associated Air Balance Council (AABC), latest edition.

- B. Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems, by the National Environmental Balancing Bureau (NEBB), latest edition.
- C. 2019 Application Handbook, Chapter 39, Testing, Adjusting and Balancing by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.4 PREINSTALLATION MEETINGS

- A. TAB Conference: Conduct a TAB conference at [Project site] <Insert location> after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of [14] <Insert number> days' advance notice of scheduled meeting time and location.
 - 1. Minimum Agenda Items:
 - a. Coordinate requirements in subparagraphs below with Section 013100 "Project Management and Coordination."
 - b. The Contract Documents examination report.
 - c. The TAB plan.
 - d. Needs for coordination and cooperation of trades and subcontractors.
 - e. Proposed procedures for documentation and communication flow.

1.5 ACTION SUBMITTALS

- A. "Pencil copy" of TAB report.
- B. Certified TAB reports.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation:
 - 1. Name and address of the proposed Balancing Contractor and that the TAB specialist and this Project's TAB team members meet the qualifications specified.
 - 2. Name of the Mechanical Contractor's representative responsible for the balancing work.
- B. Contract Documents Examination Report: Within 60 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Within 60 days Contractor's Notice to Proceed, submit the name of Balancing Contractor's representative for coordination with the Mechanical Contractor.
- D. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures.
- E. System Readiness Checklists: Within 90 days of Contractor's Notice to Proceed, submit system readiness checklists.
- F. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - a. Serial number.
 - b. Application.
 - c. Dates of use.
 - d. Dates of calibration.

1.7 QUALITY ASSURANCE

- A. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.
- B. Work shall be conducted under the supervision of an individual certified by NEBB, or AABC, or TABB by trained technicians. All test results shall be documented per the previously approved procedure and transmitted to the Architect/Engineer for review as a requisite for final acceptance and payment. Final inspection shall follow completion and acceptance of the test results.
- C. The balancing contractor shall review plans and specifications for balancing dampers, balancing valves, gauge connections, airflow/pitot sections. The Contractor shall notify the Engineer if the Contractor cannot perform the Work because of inadequate provisions so that the inadequacy can be corrected by change order during project construction without any cost over and above the device itself. No excuses during the testing and balancing procedure will be accepted for Contractor's lack of performance, and the Contractor shall be responsible for the additional cost of adding the required device(s) into the completed systems.
- D. Employment of a Balancing Subcontractor by the Contractor shall not relieve him of obligations to perform Work in accordance with the Project Documents.

1.8 FIELD CONDITIONS

- A. **Full Owner Occupancy:** Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. **Partial Owner Occupancy:** Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.
- F. Examine equipment performance data, including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.
- L. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.
- Q. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 RESPONSIBILITIES AND COORDINATION

- A. Work by Contractor, which installed the respective system to be tested, shall include the following:
 - 1. Schedule, coordinate and sequence the testing, adjusting and balancing of the respective systems. Prepare and distribute a schedule.
 - 2. Verify that the respective equipment, ductwork, piping and temperature control systems have been provided, each is operable and apparently functioning all in accordance with and to the intent of the Project Documents. In particular, the following shall be checked and noted as having been accomplished prior to the testing, adjusting and balancing:
 - a. Initial checkout and start-up of all equipment.
 - b. Pressure and leak testing, and cleaning of all systems.
 - c. Alignment and adjustment of motor drives, and lubrication of bearings.
 - d. [Air filters replaced.]
 - e. All dampers, manual line valves, control valves and balancing valves are in the “open” position.
 - 3. Verify that all instruments, measuring devices, meters, immersion wells, taps, valves, specialties, dampers, measuring and sensing elements, access openings, etc. have been provided in correct quantities and locations to permit commencement of the testing, adjusting and balancing of the Work. Correct deficiencies and/or modify the Work, as required.
 - 4. Provide the Balancing Contractor with all pertinent shop drawings on equipment to be tested, adjusted and balanced.
 - 5. Provide the Balancing Contractor with a set of “as-built” drawings or the Mechanical Contractor's marked-up “record” set showing all changes to the mechanical systems.
- B. Work by Balancing Contractor shall include the following:
 - 1. Perform a total system balance in accordance with NEBB, or AABC, or TAAB.
 - 2. Direct measurement of temperatures, pressures, air and fluid quantitative flow rates and any other values necessary to establish the status of each system in comparison with the Project Documents.
 - 3. Adjust components and devices to achieve design operating conditions within acceptable tolerances for each system. Do not use shut-off devices for balancing unless indexed. Lock memory stops or mark set points of balancing devices. Replace all system components removed temporarily during the testing and balancing effort, set all temperature controls properly and generally leave the systems in working order and “as-new” condition.

4. Report to the Architect/Engineer any existing installed or operating condition that deviates from the design or intent of the Project Documents, and that the Balancing Subcontractor believes to be beyond the scope of his work.
5. Furnish fixed sheaves to the Owner, upon acceptance of the balancing report, for fans furnished with adjustable sheaves where the balancing contractor was able to make the required speed adjustments with the factory sheave.
6. Furnish and install fixed sheaves for fans furnished with adjustable sheaves where a speed change, beyond that obtainable with the adjustable sheave, is required to obtain design airflow. The system shall be proportionally balanced, then the required fan speed shall be calculated based upon the fan laws. Contractor shall also calculate the required brake horsepower at the design airflow, if this exceeds the nameplate horsepower the Architect/Engineer shall be notified.
7. Furnish and install fixed sheaves for fans furnished with fixed sheaves where a speed change is required to obtain design airflow. The system shall be proportionally balanced, then the required fan speed shall be calculated based upon the fan laws. Contractor shall also calculate the required brake horsepower at the design airflow, if this exceeds the nameplate horsepower the Architect/Engineer shall be notified.

3.3 PREPARATION

- A. Prepare a TAB plan that includes the following:
 1. Equipment and systems to be tested.
 2. Strategies and step-by-step procedures for balancing the systems.
 3. Instrumentation to be used.
 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.
 2. Hydronics:
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.
 - c. Water treatment is complete.

- d. Systems are flushed, filled, and air purged.
- e. Strainers are pulled and cleaned.
- f. Control valves are functioning in accordance with the sequence of operation.
- g. Shutoff and balance valves have been verified to be 100 percent open.
- h. Pumps are started and proper rotation is verified.
- i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
- j. Variable-frequency controllers' startup is complete and safeties are verified.
- k. Suitable access to balancing devices and equipment is provided.

3.4 PROCEDURES

- A. The procedures listed herein are presented to enhance the procedures of the referenced agencies and the lack of a procedure being presented herein does not relieve the Contractor from following the procedures of the referenced agencies.
- B. In general, balancing dampers shall not be used to adjust the cfm quantity of fans but rather only to adjust the proportion of the airflow within the system. The fan speed shall be adjusted, with all of the dampers open, to a cfm slightly greater than design cfm. Then the dampers shall be adjusted to move more air towards the end of the system. The balancing damper at the furthest points of the system should be nearly full open. If these furthest dampers are not open then the fan speed shall be reduced and the process repeated until a satisfactory result is achieved.
- C. Prior to testing and adjusting VAV boxes the Balancing Contractor shall verify that the controllers are functioning properly and with the proper sequence of operation. If any inadequacies are encountered, they shall be reported for correction prior to testing and adjusting.
- D. Pitot tube traverses shall be taken at all branch ducts serving more than **[three (3) VAV boxes]**, more than six (6) air devices, or more than 10% of the system total airflow, and at all places indicated on the plans. The static pressure shall be recorded at each pitot tube traverse.
- E. VAV box airflow shall be measured by a pitot tube traverse in the inlet duct and measurement of the individual air device outlets, these measurements shall be used to calibrate the maximum and minimum airflows of the VAV box controller. The VAV box airflow measuring device shall not be used in the testing and balancing procedure for measuring air quantities.
- F. Systems with diversity shall be tested in accordance to a method agreed upon by Engineer and is to be established when the Contractor submits his procedures to the Engineer for approval. Typically, this may be: to force the East zones to operate design capacity while west zones are left to operate at their given load; or that some air handling units would be forced to operate at design capacity while other units may be off or left to operate at their given load.
- G. Systems with air economizer cycles shall be adjusted to provide near linear flow as the amount of outdoor varies. Three (3) conditions to be tested are minimum outdoor air, 50% outdoor air, and 100% outdoor air. Record the values of total supply, return, relief, and building differential pressure at each of these conditions. Systems with return fans shall have the return damper adjusted to provide a change from positive to negative gauge pressure to provide a negative mixed air plenum pressure.

- H. When the Contractor has any questions regarding how the systems operate or cannot obtain design performance, they should contact the Engineer for clarifications or further instruction. The work shall not be considered complete until all systems and components achieve design performance unless the Engineer issues written direction otherwise.
- I. All systems shall be adjusted between 10% above the design value as a maximum, to the design value as a minimum.
- J. Domestic hot water recirculating system shall be adjusted to provide equal flow in each branch or as otherwise indicated on the drawings.

3.5 DUCTWORK LEAKAGE TESTING

- A. Installed ductwork on systems greater than [5HP] shall be tested prior to installation of access door, take-offs, or other specialties.
- B. A testing shall be scheduled for witness per the general conditions.
- C. The supply trunk duct for each system shall be tested in whole or up to [100'] in length whichever is lesser.
- D. The return trunk duct for each system shall be tested from [50'] upstream of the fan inlet to the unit plenum box.
- E. Exhaust ductwork for each fan shall be tested from [50'] upstream of the fan inlet to the point of discharge.
- F. Outdoor air and relief air ducts for each fan system shall be tested in whole.
- G. Ductwork shall be tested as follows:
 - 1. Ductwork shall be tested in accordance with SMACNA HVAC Air Duct Leakage Test Manual.
 - 2. Use a certified orifice tube for measuring the leakage.
 - 3. Define section of system to be tested and blank off.
 - 4. Determine the design airflow for the portion of the duct to be tested.
 - 5. Determine the allowable leakage (cfm) for the section being tested.
 - 6. Pressurize to operating pressure and repair any significant or audible leaks.
 - 7. Repressurize and measure leakage.
 - 8. Repeat steps 6. and 7. until the leakage measured is less than the allowable defined in step 5.

- H. The following Leak Class and Duct Pressure Class shall be used to determine the Leakage Factor in cfm/100 S.F. Duct. Ducts shall be tested at the design pressure class. Max. leakage = Leak Class x (design pressure)^{0.65}

1. Rectangular Duct Pressure Class	Leak Class
All	6

(i.e. 4" duct systems shall be tested at 4" and the leakage shall not exceed 14.8 cfm/100 S.F. duct and 2" duct systems shall be tested at 2" and the leakage shall not exceed 9.4 cfm/100 S.F. duct)

2. Round Duct Pressure Class	Leak Class
All	3

(i.e. 4" duct systems shall be tested at 4" and the leakage shall not exceed 7.4 cfm/100 S.F. duct and 2" duct systems shall be tested at 2" and the leakage shall not exceed 4.7 cfm/100 S.F. duct)

3.6 REPORTS

- A. Reports shall be submitted in 9" x 12" binder complete with cover identification, index page, and indexing tabs. Reports shall not contain footnotes explaining why the system was not balanced to the required performance.
- B. The form of the testing and the report shall be submitted and approved prior to testing work. Reports shall be submitted on pre-approved forms.
- C. Diagrams, as required, to clarify locations of measurements and/or reading shall be included in the report.
- D. Final acceptance and payment of the contract shall not be issued before final report is approved.
- E. Air handling unit forms shall contain the following minimum information:
1. Unit Name.
 2. Make/Model.
 3. Type/Size.
 4. Serial Number.
 5. Fan Arrangement/Class/Rotation
 6. Discharge Location.
 7. Sheave Make and No.
 8. Sheave Diameter and Bore.
 9. No. Belts/Make/Size.
 10. Motor Make/Frame.
 11. Motor Horsepower.
 12. Motor Volts/Phase/Amps.
 13. Motor Full Load Amps/S.F.
 14. Motor Sheave Make and No.
 15. Motor Sheave Diameter and Bore.
 16. Sheave Centerline Distance.
 17. Design and Actual Supply CFM.
 18. Design and Actual Total S.P.
 19. Design and Actual Fan RPM.

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20. Design and Actual Motor Volts (each phase).
 21. Design and Actual Motor Amps (each phase).
 22. Design and Actual Discharge S.P.
 23. Design and Actual Suction S.P.
 24. Design and Actual Pressure Drops Across Components.
 25. Design and Actual Minimum Outside Air CFM.
 26. Design and Actual Return Air CFM.
 27. Coil Condition Wet/Dry.
 28. Filter Condition Clean/Dirty.
 29. Minimum Outside Air Damper Position (degrees 90° open; 0° closed)
 30. Maximum Outside Air Damper Position (degrees 90° open; 0° closed)
 31. Return Air Damper Position (degrees 90° open; 0° closed) for Positive Pressure on Upstream Side and Negative Pressure on Downstream Side
- F. Terminal unit forms shall contain the following minimum information:
1. VAV Box No.
 2. VAV Box Make/Size.
 3. Room Number of Area(s) Served.
 4. Design and Actual Maximum Cooling CFM.
 5. Design and Actual Minimum Cooling CFM.
 6. Design and Actual Minimum Heating CFM.
 7. Minimum static pressure required at duct static pressure sensor to provide design CFM with box air valve fully open.
 8. Flow Factor Variable for DDC Calibration
 9. [For Fan Powered Terminal Boxes:]
 10. [Motor Horsepower.]
 11. [Motor Volts/Phase/Amps.]
 12. [Motor Full Load Amps/S.F.]
 13. [Motor Speed H/M/L.]
 14. [Filter Size and Quantity.]
- G. Air Outlet forms shall contain the following minimum information:
1. Area Served.
 2. Grille Type.
 3. Grille Size.
 4. Design, Preliminary and Final CFM.
 5. Damper Position (degrees 90° open - 0° closed).
- H. Pump forms shall contain the following minimum information:
1. Pump No.
 2. Service.
 3. Make/Model.
 4. Type/Size.
 5. Serial Number.
 6. Seal Type.
 7. Design Impeller Size.
 8. Required NPSH.
 9. Motor Manufacturer/Frame Size.
 10. Motor HP/RPM.
 11. Volts/Phase/Amps.
 12. Full Load Amps.S.F.
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13. System Pressure (Pump off).
 14. Shut-off Pressure.
 15. Actual Impeller Size.
 16. Design, Preliminary, and Final Flow.
 17. Design, Preliminary, and Suction, Discharge, and Differential Pressure.
 18. Design, Preliminary, and Voltage, each phase.
 19. Design, Preliminary, and Amps, each phase.
- I. Air handling unit coil forms shall contain the following minimum information:
1. System No.
 2. Location.
 3. Service (Preheat, Cooling, Reheat).
 4. Coil Type.
 5. No. Rows/Fins per inch.
 6. Manufacturer.
 7. Model No.
 8. Face Area (Sq. Ft.).
 9. Design and Actual Air Quantity.
 10. Design and Actual Air Velocity.
 11. Design and Actual Air Pressure Drop (in. w.c.).
 12. Design and Actual Outside Air DB/WB.
 13. Design and Actual Return Air DB/WB.
 14. Design and Actual Entering Air DB/WB.
 15. Design and Actual Leaving Air DB/WB.
 16. Design and Actual Air ΔT .
 17. Design and Actual Water Flow.
 18. Design and Actual Water Pressure Drop (ft.).
 19. Design and Actual Entering Water Temperature.
 20. Design and Actual Leaving Water Temperature.
 21. Design and Actual Water ΔT .
 22. Design and Actual Inlet Steam Pressure.
 23. Design and Actual Control Valve Pressure Drop.
 24. Design and Actual Expansion Valve.
 25. Design and Actual Refrigerant Suction Pressure.
 26. Design and Actual Refrigerant Suction Temperature.
- J. Exhaust, return/relief fan forms shall contain the following minimum information:
1. Unit Name.
 2. Make/Model.
 3. Type/Size.
 4. Serial Number.
 5. Fan Arrangement/Class/Rotation
 6. Discharge Location.
 7. Sheave Make and No.
 8. Sheave Diameter and Bore.
 9. No. Belts/Make/Size.
 10. Motor Make/Frame.
 11. Motor Horsepower.
 12. Motor Volts/Phase/Amps.
 13. Motor Full Load Amps/S.F.
 14. Motor Sheave Make and No.

15. Motor Sheave Diameter and Bore.
 16. Sheave Centerline Distance.
 17. Design and Actual CFM.
 18. Design and Actual Total S.P.
 19. Design and Actual Fan RPM.
 20. Design and Actual Motor Volts (each phase).
 21. Design and Actual Motor Amps (each phase).
 22. Design and Actual Discharge S.P.
 23. Design and Actual Suction S.P.
- K. Heat Exchanger forms shall contain the following minimum information:
1. Unit Name.
 2. Service.
 3. Rating (Btu/hr).
 4. Circuiting.
 5. Manufacturer.
 6. Model Number.
 7. Serial Number.
 8. Design and Actual Steam Pressure.
 9. Design and Actual Flow Rate (#/hr).
 10. Primary Water Design and Actual Entering/Leaving Temperature.
 11. Primary Water Design and Actual ΔT .
 12. Primary Water Design and Actual Air Entering/Leaving Pressure.
 13. Primary Water Design and Actual Water ΔP .
 14. Primary Water Design and Actual Flow Rate (gpm).
 15. Secondary Water Design and Actual Water Entering/Leaving Temperature.
 16. Secondary Water Design and Actual Water ΔT .
 17. Secondary Water Design and Actual Entering/Leaving Pressure.
 18. Secondary Water Design and Actual Water ΔP .
 19. Secondary Water Design and Actual Flow Rate (gpm).
 20. Secondary Water Design and Actual Control Setpoint.
- L. Terminal Unit or VAV Coil forms shall contain the following minimum information:
1. Room No./VAV Box No.
 2. Size.
 3. Design and Actual Air Flow Rate (CFM).
 4. Design and Actual Water Flow Rate (gpm).
 5. Design and Actual Entering Water Temperature (nominal).
 6. Design and Actual Entering Air Temperature.
 7. Design and Actual Leaving Air Temperature
 8. Design and Actual Capacity (Btu/hr).

END OF SECTION 20 10 60

SECTION 20 10 70 – IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Duct labels.
 - 4. Valve tags.
 - 5. Warning signs and labels.
 - 6. Warning tape.
 - 7. Underground warning tape.
- C. Related Requirements:
 - 1. Section 20 00 00 BASIC MECHANICAL CONDITIONS
 - 2. The materials specified herein Section 20 10 70 shall apply to Division 25 Temperature Control Systems. Additional identification work is specified in Division 25

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Submit an Identification Product Schedule consisting of the following minimum information:
 - 1. Material - type of identification product.
 - 2. System - indicate which system or equipment materials will be used for.
 - 3. Manufacturer - Manufacturer's name, product name and model numbers.
 - 4. Accessories - Miscellaneous materials used in affixing identification.
- C. Submit a valve tag list for approval prior to ordering or making valve tags.
- D. Submit legends, background color, letter color, lettering sizes for [pipe markers, valve tags, and engraving wording for each equipment nameplates].

1.3 CLOSEOUT SUBMITTALS

- A. Valve tag information is required on “as-built” drawing submittals.
- B. List tagged valves in a valve schedule in the operating and maintenance manual.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufactures:
 - 1. Seton Nameplate Corp.
 - 2. Brady Signmark Division
 - 3. Craftmark Identification Systems
 - 4. D & G Sign and Label
 - 5. Or approved equipment

2.2 PERFORMANCE REQUIREMENTS

- A. Current and accepted edition of the following codes and standards shall apply to the Work of this section:
 - 1. ANSI/ASME A 13.1 - "Scheme for the Identification of Piping Systems".
 - 2. ANSI Z535.1 - "Standards for Safety Signs and Color"
 - 3. [NFPA 99 - Health Care Facilities]
 - 4. [CGA Pamphlet C-9 - "Standard Color-Marking of Compressed Gas Cylinders Intended for Medical Use in the U.S.A".]
 - 5. International Institute of Ammonia Refrigeration (IIR), Bulletin No. 114.

2.3 EQUIPMENT LABELS

- A. Plastic Labels for Indoor Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
 - 2. Letter and Background Color: As indicated for specific application under Part 3.
 - 3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
 - 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 1 inch.
 - 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- B. Metal Labels for Outdoor Equipment:
 - 1. Material and Thickness: stainless steel, 0.025 inch
 - 2. Letter and Background Color: Black filled lettering on brushed stainless steel.
 - 3. Minimum Label Size: Length and width vary for required label content, but not less than 3 by 1 inch.
 - 4.
- C. Fasteners: Stainless steel rivets or self-tapping screws.
- D. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules).
 - 1. First line: Description (i.e. Exhaust Fan, Chilled Water Pump, etc.)

2. Second Line: Unit designation (i.e. EF-1)

2.4 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
 1. Size letters in accordance with ASME A13.1 for piping. At least 1/2 inch and proportionately larger lettering for larger pipes.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to circumference of pipe and to attach to pipe without fasteners or adhesive.
 1. Integral flow arrow
 2. Up to 10 inch OD full circumference of pipe
 3. Greater than 10 inch OD, fastened with heavy duty nylon ties.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
 1. Flow direction shall be separately labeled with 2" wide pressure sensitive tape. The flow arrow band shall overlap the service label to secure it in place and shall not be less than two complete wraps around the pipe.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:
 1. Flow-Direction Arrows: Include flow-direction arrows. Arrows may be either integral with label or applied separately.
 2. Five Part Ammonia label
 - a. Piping Abbreviation
 - b. Physical State: LIQ, VAP
 - c. Pipe Contents: AMMONIA
 - d. Pressure Level: LOW, HIGH
 - e. Direction of Flow

2.5 DUCT LABELS

- A. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- D. Label Size:
 1. Ducts less than 12 inch: at least 8 by 2 inch with 3/4 inch lettering.
 2. Ducts greater than 12, less than 48 inch: at least 14 by 2-1/4 inch with 1-1/2 inch lettering.
 3. Ducts greater than 48 inch: at least 20 by 4 inch with 2-1/2 inch lettering.

2.6 VALVE TAGS

- A. Description: Stamped or engraved with 1/4 letters for piping system abbreviation and 1/2-inch numbers that are black enamel filled.

1. Tag Material: Brass, 1-1/2 inch diameter, 0.04-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: No. 6 brass bead chain or No. 16 brass jack chain

2.7 WARNING SIGNS AND LABEL

- A. Material: Vinyl.
- B. Minimum Thickness: 0.005 inch (0.12 mm).
- C. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.
- D. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.
- E. Maximum Temperature: 160 deg F (70 deg C).

2.8 WARNING TAPE

- A. Material: Vinyl.
- B. Minimum Thickness: 0.005 inch.
- C. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.
- D. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.
- E. Maximum Temperature: 160 deg F.
- F. Minimum Width: 2 inches.

2.9 UNDERGROUND WARNING TAPE

- A. General Requirements for Manufactured Warning Tape: Preprinted, color coded, with lettering indicating service
- B. Polyethylene, 6" wide, 4 mills
- C. Detectable, Polyester encased Aluminum foil, 6" wide, 5 mills

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

- A. Permanently fasten labels on each item of mechanical equipment.
- B. Sign and Label Colors:
 - 1. White letters on an ANSI Z535.1 safety-blue background.
- C. Locate equipment labels where accessible and visible.
- D. Nameplates shall be installed with corrosion-resistant mechanical fasteners. Do not use adhesives.

3.4 INSTALLATION OF PIPE LABELS

- A. Label each mechanical and plumbing piping system.
- B. Installed in accordance with the manufacturer's recommendations.
- C. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
- D. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Within 3 ft. of each valve and control device.
 - 2. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 3. Within 3 ft. of equipment items and other points of origination and termination.
 - 4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping, ductwork, and equipment.
- E. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation.
- F. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

G. Pipe -Label Type Schedule:

<u>Location</u>	<u>Type</u>
Interior, non-mechanical room	Self-Adhesive Pipe Labels
Interior Mechanical room	Pretensioned Pipe Labels

Exterior /Outdoors
for outdoors

Pretensioned Pipe Labels – non-vinyl chloride designed

- H. Pipe-Label Color Schedule:
Colors shall be as follows:

<u>Color Scheme ASME A13.1 – current)</u>	<u>Fluid Service</u>
White letters on Red Background	Fire quenching fluids
Black letters on Orange Background	Toxic and corrosive fluids
Black letters on Yellow Background	Flammable and oxidizing fluids
White letters on Green Background	Potable, cooling, roof drain , drain, waste, vent
boiler feed, and other water	
White letters on Brown Background	Combustible fluids
White letters on Blue Background	Compressed gases, non-flammable, non-toxic

<u>Color Scheme ASME A13.1 – 1996</u>	<u>Fluid Service</u>
White letters on Red Background	Fire quenching fluids
Black letters on Orange Background	Toxic and corrosive fluids
Black letters on Yellow Background	Inherently hazardous – Natural gas, Hot fluids,
Refrigerant, waste, vent, and Steam	
White letters on Green Background	Potable, cooling, and other Inherently safe water
White letters on Brown Background	Combustible fluids
White letters on Blue Background	Compressed air

INSTALLATION OF DUCT LABELS

- I. Label each duct system.
- J. Installed in accordance with the manufacturer's recommendations.
- K. Install duct labels showing service and flow direction with permanent adhesive on air ducts uninsulated or insulated, exposed or concealed, except for exposed ductwork in finished areas.
- L. Labels shall be installed in clear view; installed on both sides of the duct; run parallel to the ductwork; located at not more than twenty-five foot (25') intervals on straight runs at all branch locations; and located on each side of penetrations of the building structure and non-accessible enclosures
- M. Duct-Label Color Schedule:
- For air supply ducts: White letters on blue background
 - For air return ducts: White letters on blue background
 - For exhaust-, outside-, relief-, return-, and mixed-air ducts: White letters on blue background.
 - Outdoor air labels shall have an “air” legend.
 - Hazardous exhaust air: Black letters on yellow background

3.5 INSTALLATION OF VALVE TAGS

- A. Install tags on all valves exposed or concealed, unless indicated otherwise. shall be identified indicating the service of system the valve is in and the number of the valve. List tagged valves in a valve schedule in the operating and maintenance manual.
- B. Valves that tags are not required:
 - 1. Check valves
 - 2. Balance valves that are not used as a combination balance/service valve
 - 3. Valves within factory-fabricated equipment
 - 4. Shut off valves for terminal equipment that are located with 6 feet of device with the pipe visible, and with no pipe branches located between the valve and the equipment.
- C. Legends shall be HVAC, PLBG, SPR, and GAS.
- D. Temperature control valves shall be identified with a ¼" "T.C." legend and shall be numbered consecutively starting with major equipment and then terminal units (i.e., AHU-1 preheat, cooling, reheat control valves shall be numbered 1, 2, 3 respectively).
- E. Chains shall be attached to the valve lever handle or around the valve stem.
- F. An additional 10 consecutively numbered tags for each service shall be provided to the Owner for future use.
- G. Service valves and isolation valves shall be labeled consecutively with supply being odd and return even (i.e., chilled water pump service valves shall be No. 1 on pump discharge and No. 2 on pump suction). Where a valve does not have a match skip the next number. All single valves for make-up water, expansion tanks, etc. can be numbered consecutively and shall be last in the sequence.

3.6 INSTALLATION OF WARNING TAGS

- A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.
- B. Attach warning tags, with proper message, to equipment and other items where indicated on Drawings, and herein.
- C. Equipment that is controlled by the Building Automation Control System shall be labeled with a 2" x 5" label reading:
CAUTION – THIS EQUIPMENT IS UNDER COMPUTER CONTROL AND MAY CYCLE AT ANY TIME.

3.7 INSTALLATION OF WARNING TAPE

- A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes
- B. Install warning tape on pipes and ducts, at walkways or isles providing less than 6 ft. of clearance above finished floor including items located near the floor that are trip hazards.
- C. Locate tape so as to be readily visible from the point of normal approach.

3.8 INSTALLATION OF UNDERGROUND WARNING TAPE

- A. Install underground warning tape for each below grade pipe or conduit exterior to the building.
- B. Warning tape shall be positioned approximately 6" below finished grade and directly above the piping / utility.
1. Metallic piping shall be identified with continuous polyethylene warning tape
 2. Non-metallic piping shall be identified with continuous metallic detectable warning tape
- C. The following legend, color, and lettering shall be used for below ground:

<u>Service</u>	<u>Color</u>	<u>Legend</u>
Electric 4160 V	Red	Caution Buried High Voltage Electric
Electric	Red	Caution Buried Electric
Fiber Optic	Orange	Caution Buried Fiber Optic
Telephone	Orange	Caution Buried Communication
CATV	Orange	Caution Buried CATV
Sewer	Green	Caution Buried Sewer
Potable Water	Blue	Caution Buried Water
Non-potable Fire	Purple	Caution Buried Reclaimed Water
Natural Gas	Yellow	Caution Buried Gas
Fuel Oil	Yellow	Caution Buried Fuel
Steam	Yellow	Caution Buried Utility Line
Chilled Water	Purple	Caution Buried Reclaimed Water
Condenser Water	Purple	Caution Buried Reclaimed Water
Heating Water	Purple	Caution Buried Reclaimed Water
Condensate	Purple	Caution Buried Reclaimed Water
Irrigation Water	Purple	Caution Buried Reclaimed Water

END OF SECTION 20 10 70

SECTION 20 20 10 – ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Motors
 - 2. Motor Controls
 - 3. Disconnect Switches
 - 4. Multi-speed Motors and Controls
 - 5. Variable Speed Drives
 - 6. Control Panel
- B. Related Requirements:
 - 1. Section 20 00 00 BASIC MECHANICAL CONDITIONS

1.2 GENERAL

- A. This Subsection specifies the basic requirements for electrical components which are an integral part of “packaged” mechanical equipment. These components include, but are not limited to, factory installed motors, starters, disconnect switches, control panels and related prewiring of power and control wiring for a single external electrical service connection. All material and equipment shall be provided for the application and service intended.
- B. Specific electrical requirements (e.g. horsepower, electric characteristics, etc.) for mechanical equipment shall be specified within the respective equipment specifications or shall be scheduled on the Plans.
- C. The Contractor shall verify that electrical characteristics of material and equipment furnished for Divisions 20 - 25 equipment are in accordance with the electric service and comply with the specifications and requirements of Division 26 - 29.
- D. Unless otherwise specified as an integral part of packaged mechanical equipment, motor control centers, motor starters and disconnect switches and the power wiring from power source to motor starting equipment (including variable frequency drive packages) and wiring from that equipment to the respective motors including final connections shall be performed as Electrical Work of Division 26 - 29.
- E. The field installation of electrical components, not included in Division 26 - 29, that are specified to be provided with the mechanical equipment and are shipped separately shall be the responsibility of the Contractor furnishing the base equipment.
- F. All electrical components and material shall be UL labeled.
- G. Submittals for the applicable electrical equipment shall include the following: identification of the equipment which the electrical material is to serve, application, voltage, phases, full load amperage, wattage and NEMA enclosure. For motors: horsepower, RPM, full load power factor and efficiency, frame size and service factor.

- H. Identification of electrical components of mechanical equipment shall be in accordance with Subsection 20 10 90, "Basic Mechanical Methods - Identification".

1.3 REFERENCES

- A. Electrical material and equipment provided for Divisions 20 - 29 shall meet the applicable requirements of the latest accepted edition of the following codes and standards:
 - 1. ANSI American National Standards Institute
 - 2. EEI Edison Electrical Institute
 - 3. IEEE Institute of Electrical and Electronic Engineers
 - 4. NEC National Electrical Code
 - 5. NEMA National Electrical Manufacturers Association
 - 6. UL Underwriter's Laboratories, Inc.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Motors
 - 1. Baldor
 - 2. General Electric
 - 3. Gould
 - 4. Marathon
 - 5. Magnetek
 - 6. Reliance
 - 7. Siemens

8. Toshiba
9. U.S. motors

- B. Motor Controls
1. Allen-Bradley
 2. Eaton
 3. General Electric
 4. Siemens
 5. Square D

2.3 MOTORS

- A. The following are basic minimum requirements for all motors. Additional motors, more detailed and specific requirements may be specified with the respective equipment.
- B. Single-phase motors shall be provided for all motors 1/2 HP or less, except as specified or scheduled otherwise and shall be of the permanent split capacitor (PSC) type.
- C. Polyphase motors shall be provided for all motors 3/4 HP or larger, except as specified or scheduled otherwise with a minimum power factor of .85 at 65% of full load or shall be power factor corrected.
- D. Multi-speed motors shall have dual windings wound to the speeds scheduled or specified.
- E. Torque characteristics shall be sufficient to satisfactorily accelerate the driven load(s) with low in rush current.
- F. Motor horsepower sizes shall be large enough so that the driven load shall not require the motor to operate in the service factor range.
- G. Temperature rating: Rated for 40 deg. C environment with maximum temperature rise for continuous duty at full load of 40°C for open dripproof motors, 50°C for splash proof motors, and 55°C for totally enclosed motors (Class B insulation). Motors used with variable frequency drives/inverters shall be NEMA MG1, Part 31 Compliant and have a Class B temperature rise with Class F insulation design to resist transient spikes, high frequencies, and short rise time pulses produced by inverters.
- H. Starting capability: Frequency of starts as specified by the automatic control system. For manually controlled motors, not less than five (5) evenly time spaced starts per hour.
- I. Service factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
- J. Motor construction:
1. NEMA standard frame sizes, general-purpose open dripproof (unless otherwise specified), continuous duty, Design "B" (unless "C" is required for high starting torque). Motor frame, end bells and conduit box shall be cast iron; stator windings shall be copper. Aluminum is unacceptable for any parts. Provide grounding lug in motor terminal box.
 2. Motors located outdoors or otherwise exposed to water, dust, etc where an open motor would not be suited, shall be totally enclosed fan-cooled (TEFC).

3. Bearings: Ball or roller bearings with inner and outer shaft seals. Externally accessible inlet/outlet grease fittings. Where motors are enclosed within equipment, extend grease tubing to exterior of the enclosure. Bearings designed to resist thrust loading for drives producing lateral or axial thrust. Fractional horsepower, light duty motors may have sleeve bearings.
4. Overload protection: Built-in thermal overload protection.
5. Noise rating: Motors shall meet IEEE, Standard 85.
6. Efficiency: Motors shall be NEMA Premium Efficiency per NEMA Standards Publication MG 1-2021.
7. Nameplate: Indicate full identification of manufacturer's name, model number, serial number, horsepower, speed, voltage, characteristics, construction, special features, etc. Nameplates in harsh environments such as for cooling towers, or in pool equipment rooms, etc. shall be suited to the specific application.
8. Comply with IEEE 841 for severe-duty motors

2.4 MOTOR CONTROLS

- A. Motor Starters: NEMA 1, general-purpose enclosures with padlock ears, unless specified other wise. Type, size and duty shall be as specified or as recommended by the motor manufacturer and the requirements of the driven equipment for applicable protection and start-up conditions.
- B. Manual Starters: Pilot light and extra positions for multi-speed motors. Melting alloy type thermal overload relay protection.
- C. Magnetic Starters: Hand-off-Auto selector switches, pilot lights, interlock contacts, switches and other devices as required for control requirements. Trip-free thermal overload relays for each phase. Built-in 120 volt control circuit transformer, fused from line side, where power service exceeds 240 volts. Externally operated manual reset; under-voltage release of protection.

2.5 DISCONNECT SWITCHES

- A. Fusible: For 3/4 horsepower and larger. Disconnect switch shall be horsepower rated, heavy duty, spring reinforced fuse clips each phase, quick-make/quick-break mechanism with arc quenchers, dead front line side shield, solderless lugs, silver electroplated current carrying parts, lockable hinged door, capacity and electric characteristics as specified.
- B. Non-fusible: For 1/2 horsepower motor and smaller. Disconnect switch shall be horsepower rated, toggle switch type, quantity of poles and voltage rating as specified.

2.6 MULTI-SPEED MOTORS AND CONTROLS

- A. Multi-speed motors, when required, shall be specified under the heading of the respective equipment to be driven.
- B. Motor controls for multi-speed applications shall be specified, also, under the heading of the respective equipment, if said equipment is a "packaged" type unit.
- C. Otherwise, multi-speed motor controls shall be specified in Division 26.

2.7 VARIABLE SPEED DRIVES

- A. Motor controls for variable speed drives shall be specified under the heading of the respective equipment, if said equipment is a “packaged” type unit.
- B. Otherwise, variable speed drives shall be specified in Division 26.

2.8 CONTROL PANEL

- A. NEMA 1 general-purpose enclosure for indoor application; NEMA 3R weather resistant enclosure for exterior location.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide motors, motor controls and accessories as specified and scheduled on the drawings.
- B. Control Panel
 - 1. Factory mount panel(s) and internal power and control devices. Pre-wire all devices for the operation of the related equipment so that only one main power connection shall be required in the field.
 - 2. Provide internal protection for each circuit, maximum 120-volt secondary control transformer(s), terminal strips for wiring terminations, identification of components and wiring diagram inside the cover.

END OF SECTION 20 20 10

SECTION 20 20 20 – DRIVES and GUARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. V-Belt Drives
 - 2. Direct-coupled Drives
 - 3. Guards
- B. Related Requirements:
 - 1. Section 20 00 00 BASIC MECHANICAL CONDITIONS

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. All drives shall be selected for 150% of specified motor nameplate horsepower.

2.2 MANUFACTURERS

- A. V-Belt Drives
 - 1. Browning
 - 2. Eaton
 - 3. Gates

2.3 V-BELT DRIVES

- A. All motors shall be provided with variable pitch pulleys with design RPM at mid-range of adjustment.
- B. V-belts shall be premium quality, endless cord impregnated rubber with trapezoidal cross section, type A, B, C or D, matched set (if more than one), 95% minimum drive efficiency.
- C. The driving motor shall be installed on an adjustable bolt device to provide for belt tension adjustment.

2.4 DIRECT DRIVES

- A. Wherever available, motors and related direct driven equipment shall be mounted on a common base.

2.5 GUARDS

- A. Guards shall be designed and arranged in accordance with OSHA requirements.
- B. Guards shall completely enclose the drive, shall be secured to the respective equipment and shall be removable for servicing. Wherever available from the manufacturer, guards shall be provided with the equipment. If not, these shall be field fabricated.
- C. Provide reinforced openings with removable cover plates for access to motor and driven shafts for speed measurement.
- D. Extend tubing for grease fittings inside the guard to accessible locations outside the guard.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide drives of the type scheduled and specified with the associated equipment.
- B. Provide OSHA guards on each rotating equipment with exposed rotating parts.
- C. Install, balance and align all drives in accordance with the respective manufacturer's instructions and recommendations.
- D. The balancing and alignment of drives including pinning, doweling and grouting shall be the responsibility of the Contractor furnishing the equipment. Any adversities arising from executing the Work shall be resolved/remedied by the Contractor.
- E. Verify all electrical characteristics prior to running electric motor driven equipment. Check motor amperage draw and rotation for proper operation.

END OF SECTION 20 20 20

SECTION 20 20 25 – INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Glass Fiber Insulation (aka Fiberglass)
 - 2. Elastomeric Foam Insulation
 - 3. Polyisocyanurate Foam Pipe Insulation
 - 4. Polyisocyanurate Foam Board Insulation
 - 5. Cellular Glass Insulation
 - 6. Metal jackets
 - 7. PVC covers
 - 8. Self-adhesive exterior duct jacket
 - 9. Mastics, Coatings, Sealants, & Adhesives
 - 10. Fasteners
 - 11. Fire Stop
- B. Related Requirements:
 - 1. Section 20 00 00 BASIC MECHANICAL CONDITIONS
- C. Provide appropriate size calcium silicate/cellular glass/pipe shield manufactured inserts to the trade contractor for installation between the pipes and oversized hangers as specified in this section.
- D. Fire wrap piping system located in occupied spaces or plenum spaces that do not meet flame spread 25 and smoke development 50.

1.2 DEFINITIONS

- A. The term “fitting” where used in this Section of the Specifications shall be construed as an elbow, tee or reducer. Unions, flanges and valves shall not be considered as fittings.
- B. The term “cold” shall be defined as the temperature of a surface that may result in the formation of condensation.
- C. The term “accessory” shall include staples, bands, wire, mesh, clips, pins, studs, tape, anchors, corner angles, cements, adhesives, coatings, sealers, mastics, finishes, etc.
- D. The term “ASJ” where used in this Section of the Specifications shall mean a reinforced vapor retarding All Service Jacket.
- E. The term “SSL” where used in this Section of the Specifications shall mean Self-sealing Lap Joint closure system for longitudinal jacket joints.
- F. The term “supply air” where used in this Section of the Specifications shall mean downstream of a coil.

- G. The term “outdoor air” where used in this Section of the Specifications shall mean ambient air that has not been conditioned.
- H. The term “return air” where used in this Section of the Specifications shall mean conditioned air that is returned from the space.
- I. The term “mixed air” where used in this Section of the Specifications shall mean air streams that are a mixture of “outdoor air” and “return air”.
- J. The term “relief air” where used in this Section of the Specifications shall mean excess return air that is relieved from the building.
- K. The term “exhaust air” where used in this Section of the Specifications shall mean air that is removed due to contaminates, odors, or heat.

1.3 REFERENCES, REGULATORY REQUIREMENTS

- A. Work for this Section of the Specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Division 20 in addition to the following:
 - 1. State and local Air Pollution Codes and Regulations.
 - 2. NFPA 255/UL 723/ASTM E-84 Surface Burning Characteristics of Building Materials.
 - 3. UL 1479/ASTM E-814 Fire Test of Through-Penetration Firestops.
 - 4. ASTM C547 Standard Specification for Mineral Fiber Pipe Insulation.
 - 5. ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - 6. ASTM C1071 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - 7. ASTM C1290 Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
 - 8. ASTM C1136 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 - 9. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - 10. NFPA 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - 11. North American Commercial and Industrial Insulation Standards. 9th Edition or Latest Edition. Published by Midwest Insulation Contractors Association (MICA).

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Provide manufacturer's technical product data of each material and accessory item with engineering support information and recommended installation procedure. Indicate product number, “K” value, thickness and required accessories for each application.
- B. Provide an insulation product schedule consisting of the following minimum information:
 - 1. Material - type of insulation material, jackets, or covers.
 - 2. Manufacturer - manufacturers name, product name, and K-value where applicable.
 - 3. Accessories - tapes, staples, coatings, adhesives including manufacturer's name and product name.

4. Systems - indicate systems where product is used
5. System - indicate which system insulation is installed.
6. Location - inside, outside, concealed, exposed, etc.
7. Size - indicate size range of pipe, insulation type used.
8. Thickness - indicate insulation thickness in inches.

1.5 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.6 CLOSEOUT SUBMITTALS

- A. Self-Adhesive Outdoor Jacket warranty information and copy of sales receipt and other information required for warranty claim.

1.7 QUALITY ASSURANCE

1. Contracting company shall be one specializing in insulation application and have a minimum of three (3) years experience in this work.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers are to be marked with the manufacturer's name, appropriate ASTM standard designation, type and grade, and maximum use temperature.
- B. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.
- C. The Contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The Contractor shall also use all means necessary to protect work and materials installed by other trades.
- D. If any insulation material has become wet because of transit or job site exposure to moisture or water, the Contractor shall not install such material, and shall remove it from the job site. An exception may be allowed in cases where the Contractor is able to demonstrate that wet insulation when fully dried out (either before installation, or afterward following exposure to system operating temperatures) will provide installed performance that is equivalent in all respects to new, completely dry insulation. In such cases, consult the insulation manufacturer for technical assistance and provide the Architect/Engineer with a copy of manufacturer's recommendation for approval.

1.9 WARRANTY

- A. Self-Adhesive Outdoor Jacket shall have a 10 year manufacturer warranty.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Materials and accessories furnished for this Section of the Specifications shall be standard cataloged products, new, commercially available and suitable for the service specified.
- B. Insulations materials shall not contain formaldehyde, asbestos, lead, mercury, mercury compounds, or polybrominated diphenyl ether fire retardants.
- C. Fiberglass insulations shall be constructed of bio-soluble fiber, certified by EUCB.
- D. Fiberglass insulations shall have a minimum of 50 percent recycled glass content; certified and validated in accordance with UL 2809.
- E. Fiberglass insulations shall have a bio-based, formaldehyde-free binder and be UL GREENGUARD Gold certified.
- F. All insulation material shall have composite fire and smoke hazard ratings in accordance with NFPA 255 and UL 723 not exceeding the following values as tested by the latest procedures of ASTM E-84: flame spread of 25; smoke developed of 50.
- G. Accessories such as adhesives, mastics, cements, tapes and cloths for seams, joints and fittings shall have the same ratings as hereinbefore listed. All products and their respective shipping cartons shall have indications that flame and smoke ratings meet the aforementioned requirements. Any treatment of jackets or facings to impart acceptable flame and smoke safety values shall be permanent; water-soluble applications are prohibited. The Insulation Contractor shall bear responsibility that all products to be used meet the foregoing criteria

2.2 MANUFACTURERS

- A. Metal jackets
 - 1. RPR Products, Inc.
 - 2. Ideal Products
 - 3. Johns Manville
 - 4. Shur-Fit Products
- B. PVC covers
 - 1. Proto Corp. (Lo Smoke)
 - 2. Speedline PVC Corp. (Smoke Safe)
 - 3. Johns Manville (Zeston)
 - 4. Shur-Fit Products
 - 5. P.I.C. Plastics
- C. Self-adhesive Exterior Duct Jacket
 - 1. AlumaGuard All Weather by Polyguard Products
 - 2. FlexClad by MTM Building Products
 - 3. VentureClad by 3M

- D. Mastics, Coatings, Sealants, & Adhesives
 - 1. Miracle Adhesives
 - 2. Vimasco Corporation
 - 3. Childers Products / H.B. Fuller Construction Products
 - 4. Foster Products / H.B. Fuller Construction Products
 - 5. Mon-Eco Industries
- E. Fasteners
 - 1. ACS Industries
 - 2. GEMCO
 - 3. Midwest Fasteners
- F. Fire Stop
 - 1. 3M
 - 2. Metacaulk
 - 3. Specified Technologies, Inc.
 - 4. USG Interior, Inc.
 - 5. Alkegen Unifrax
 - 6. Morgan Advanced Materials - Thermal Ceramics
- G. Glass Fiber Insulation (aka Fiberglass):
 - 1. Knauf Insulation
 - 2. Manson Insulation
 - 3. Owens Corning
 - 4. Johns Manville
 - 5. CertainTeed
- H. Elastomeric Foam Insulation:
 - 1. Armacell North America
 - 2. Aeroflex USA
 - 3. K-Flex USA
- I. Polyisocyanurate Foam Pipe Insulation:
 - 1. Johns Manville (Trymer PIR)
- J. Polyisocyanurate Foam Board, Glass-Fiber-Mat Faced Insulation:
 - 1. Atlas
 - 2. RMax
- K. Cellular Glass Insulation:
 - 1. Owens Corning (Rigid Foamglas)

2.3 CALCIUM SILICATE (Type CS)

- A. Hydrous calcium silicate, molded pipe or block form, asbestos free, ANSI/ASTM C533, Type I, “k” value of 0.41 at 200 degrees F for pipe, “k” value of 0.39 at 200 degrees F for block, density of 15#/cubic foot.
- B. Owens-Corning Calcium Silicate or equivalent by Knauf, Manville or Pabco.

2.4 GLASS-FIBER PREFORMED FOR PIPE AND TUBE (Type GF1)

- A. Glass fibers bonded with a bio-based thermosetting resin, non-combustible, complying with ASTM C547, Type I and IV, Grade A; ASTM C585, ASTM C411, ASTM C795. One piece, mandrel wound construction with factory pre-slit sidewall.
 - 1. Provide with factory-applied white ASJ+ SSL vapor retarder jacket with self-sealing lap closure and butt strips, complying with ASTM C1136.
 - 2. Maximum service temperature of 1,000 degrees F.
 - 3. Thermal conductivity (k-value) at 75 degrees F mean temperature shall be 0.23 Btu x in. /h x sq. ft. x degrees F, or less.
 - 4. Maximum Flame spread rating of 25 and Smoke developed rating of 50 when tested in accordance with ASTM E84 or UL 723.
 - 5. Must be NFPA 90A and 90B compliant, UL Environment GREENGUARD Gold certified, UL Validated Formaldehyde-free, UL Validated for Recycled Glass Content of 50% minimum.
- B. Knauf Insulation Earthwool 1000 Pipe Insulation with ECOSE, Manson Insulation Alley-K Pipe Insulation with ECOSE, Owens Corning SS-II with ASJ or ASJ Max Fiberglas Pipe Insulation, or Johns Manville; Micro-Lok HP or HP Ultra Pipe Insulation

2.5 GLASS-FIBER PREFORMED FOR PIPE AND TANK (Type GF1A)

- A. Glass fibers bonded with a bio-based thermosetting resin, non-combustible, complying with ASTM C547, Type I and IV, Grade A; ASTM C585, ASTM C411, ASTM C795. One piece, mandrel wound construction with factory pre-slit sidewall.
 - 1. Provide with factory-applied white ASJ+ SSL vapor retarder jacket with self-sealing lap closure and butt strips, complying with ASTM C1136.
 - 2. Maximum service temperature of 1,000 degrees F.
 - 3. Thermal conductivity (k-value) at 75 degrees F mean temperature shall be 0.23 Btu x in. /h x sq. ft. x degrees F, or less.
 - 4. Maximum Flame spread rating of 25 and Smoke developed rating of 50 when tested in accordance with ASTM E84 or UL 723.
 - 5. Must be NFPA 90A and 90B compliant, UL Environment GREENGUARD Gold certified, UL Validated Formaldehyde-free, UL Validated for Recycled Glass Content of 50% minimum.
- B. Knauf Insulation Earthwool Pipe and Tank Insulation, Owens Corning Fiberglas Flexwrap with ASJ Max Fiberglas Pipe & Tank Insulation, or Johns Manville; Micro-Flex Pipe and Tank Insulation with AP facing.

2.6 GLASS-FIBER RIGID BOARD (Type GF2)

- A. Glass fibers bonded with a bio-based thermosetting resin, non-combustible, complying with ASTM C612 (Type IA, IB).
 - 1. Provide insulation with factory-applied white ASJ+ facing complying with ASTM C1136.
 - 2. Thermal conductivity (k-value) at 75 degrees F mean temperature shall be 0.24 Btu x in. /h x sq. ft. x degrees F, or less.
 - 3. Maximum service temperature of 450 degrees F.
 - 4. Nominal density shall be 3.0 PCF.

5. Maximum Flame spread rating of 25 and Smoke developed rating of 50 when tested in accordance with ASTM E84 or UL 723.
 6. Must be NFPA 90A and 90B compliant, UL Environment GREENGUARD Gold certified, UL Validated Formaldehyde-free, and UL Validated Recycled Glass Content of 50% minimum.
- B. Knauf Insulation Earthwool Insulation Board with ECOSE, Manson Insulation; AK Board™ with ECOSE, Owens Corning Type 703 Insulation Board, Johns Manville; 800 Series Spin-Glas Insulation Board, or CertainTeed CertaPro Commercial Insulation Board.

2.7 GLASS-FIBER FLEXIBLE BLANKET (Type GF3)

- A. Glass fibers bonded with a bio-based thermosetting resin, non-combustible, complying with ASTM C1290 and ASTM C553, Type I, II, and III.
1. Provide insulation with factory-applied white ASJ+ vapor retarding facing complying with ASTM C1136.
 2. Thermal conductivity (k-value) at 75 degrees F mean temperature shall be 0.27 Btu x in. /h x sq. ft. x degrees F, or less.
 3. Maximum service temperature of 250 degrees F with facing, 350 degrees F for unfaced material. Nominal density shall be 1.0 PCF and thickness to achieve required R-Value.
 4. Maximum Flame spread rating of 25 and Smoke developed rating of 50 when tested in accordance with ASTM E84 or UL 723.
 5. Must be NFPA 90A and 90B compliant, UL Environment GREENGUARD Gold certified, UL Validated Formaldehyde-free, and UL Validated for Recycled Glass Content of 50% minimum.
- B. Knauf Insulation Atmosphere Duct Wrap with ECOSE, Manson Insulation; Alley Wrap™ B Duct Wrap with ECOSE, Owens Corning SoftR Duct Wrap, Johns Manville Microlite Duct Wrap, or CertainTeed; SoftTouch Duct Wrap.

2.8 FLEXIBLE ELASTOMERIC PREFORMED FOR PIPE AND TUBE (Type F1)

- A. Flexible elastomeric foamplastic with smooth exterior surface, preformed for pipe and tube application, ASTM C534, Type I, “k” value of 0.28 at 75 deg. F.
- B. Armacell AP Armaflex pipe insulation, K-Flex LS tube, or AeroFlex EDPM tube.

2.9 FLEXIBLE ELASTOMERIC SHEET (Type F2)

- A. Flexible elastomeric foamplastic with smooth exterior surface, sheet material, ASTM C534, type II, “k” value of 0.28 at 75 degrees F.
- B. Armacell AP Armaflex sheet material, K-Flex LS sheet, or AeroFlex EDPM sheet.

2.10 RIGID FOAMGLASS PREFORMED FOR PIPE AND TUBE (Type FG)

- A. Rigid foamglass preformed for pipe applications ASTM C552, K value of 0.33 at 75°F with all-purpose vapor retarder jacket.

- B. Owens Corning Foamglas.
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- 2.11 POLYISOCYANURATE PREFORMED FOR PIPE AND TUBE (Type PI1)
 - A. Polyisocyanurate preformed for pipe applications ASTM C591, aged “k” value of 0.19 at 75 degrees F, density of 2#/cubic foot. Shall be ASTM E84 less than 25/50 rated. Saran 560 vapor barrier.
 - 2.12 POLYISOCYANURATE RIGID BOARD (Type PI2).
 - A. Polyisocyanurate preformed flat and tapered board. ASTM C591, aged “k” value of 0.19 at 75 degrees F, density of 2#/cubic foot.
 - 2.13 FIRE-RATED INSULATION SYSTEMS (Type FR1)
 - A. Fire-Rated Board:
 - 1. Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F (927 deg C).
 - 2. Comply with ASTM C656, Type II, Grade 6.
 - 3. Tested and certified to provide a [1] [2]-hour fire rating by an NRTL acceptable to authorities having jurisdiction.
 - 2.14 FIRE-RATED INSULATION SYSTEMS (Type FR2)
 - A. Fire-Rated Blanket:
 - 1. High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a [1] [2]-hour fire rating by an NRTL acceptable to authorities having jurisdiction.
 - 2.15 FACTORY-APPLIED JACKETS
 - A. Factory-applied Vapor Retarder Jacket - ASJ+-SSL is ASJ+ jacket equipped with Self-Sealing Lap Advanced Closure System; complying with ASTM C 1136 Type I, II, III, IV, and VII secured with self-sealing longitudinal laps and matching ASJ+ butt wraps.
 - B. Factory-applied Vapor Retarder Jacket - ASJ+ is All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a white kraft paper interleaving with an outer polymer film leaving no paper exposed; complying with ASTM C 1136 Type I, II, III, IV, and VII.
 - 2.16 FIELD-APPLIED JACKETS
 - A. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
 - B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

- C. Aluminum Jacket: Aluminum Jacket: Comply with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - 1. Moisture Barrier for interior and exterior applications: at least 3 mil polyfilm.
 - 2. Moisture Barrier shall have ASTM E84 flame/smoke performance of $\leq 25/50$.
- D. Stainless steel Jacket: Stainless Steel Jacket: ASTM A240/A240M.
 - 1. Moisture Barrier for interior and exterior applications: at least 3 mil polyfilm.
 - 2. Moisture Barrier shall have ASTM E84 flame/smoke performance of $\leq 25/50$.
- E. Self-Adhesive Outdoor Jacket (Asphaltic): minimum 9-mil [45 mils] thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross laminated polyethylene film covered with [white] [stucco-embossed] aluminum-foil facing.

2.17 TAPES

2.18 SECUREMENTS

2.19 CORNER ANGLES

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Furnish and install insulation, jacketing, adhesives, sealants, and necessary accessories for the following systems where shown on the Plans and as hereinafter specified. Include all necessary considerations in the related sections of the Specifications (Subsection 20 25 03) to perform the Work completely.
 - 1. Chilled water piping (including chilled glycol and brine).
 - 2. Heating water piping.
 - 3. Combination chilled/hot (heating) water piping.
 - 4. Refrigerant piping [suction, hot gas/discharge, heat recycling and reheat].
 - 5. Condensate drain piping.
 - 6. Waste piping and floor drains located above grade serving condensate drains.
 - 7. Make-up cold water piping.
 - 8. Low pressure (15# and less) steam supply piping.
 - 9. LP steam condensate return and condensate pump discharge.

10. Medium pressure (16# to 50#) steam supply piping.
 11. High pressure (51# and over) steam supply piping.
 12. MP and HP steam condensate return and condensate pump discharge.
 13. Chilled water pumps, equipment and specialties.
 14. Reheat coils and return bends of uncased coils, including VAV boxes.
 15. Heat exchangers and other heating equipment.
 16. Ductwork/sheetmetal systems.
 17. Fire wrapping kitchen exhaust duct.
 18. Boiler breechings and water heater flues.
 19. Domestic hot, hot recirculating and cold-water piping.
 20. Domestic hot water storage tanks and other equipment.
 21. Storm water drainage.
 22. Laboratory piping and equipment.
 23. Heat traced piping (above grade).
 24. Miscellaneous: engine exhaust, high temperature hydronic piping, process piping, etc.
 25. Chiller water boxes and miscellaneous chiller specialties.
- B. Respective piping system, duct system and/or equipment shall be pressure tested, proved tight and accepted, as specified in section for installation of such, before insulation is applied. Sheet metal ductwork joints shall be sealed prior to insulating. Coordination among the respective contractors is essential.
- C. Insulation materials and accessories shall be applied in accordance with respective manufacturer's recommendations and recognized industry practice for the insulation to serve its intended purpose. All surfaces to receive insulation shall be clean, dry, free of oxidation and prepared as required.
- D. The insulation work shall be subject to inspection during the various applications and construction phases. Material, accessories, finishes, methods and workmanship that are not in compliance with these Specifications and/or approved submittals may lead to rejection of the Work and replacement at the Contractor's expense.
- E. Tie-ins to existing systems and all new work shall be insulated to provide a complete and functional system. Finishes shall be compatible wherever possible.
1. When existing insulation thickness is different than the specified thickness herein, the Contractor shall notify the Architect/Engineer. It is the intent that the existing piping would be restored to its original condition (thickness and finish) as if new work had not been performed.
- F. Field-applied Insulation for Piping
1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
 2. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.
 3. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.
 4. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.
 5. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
 6. Painting of piping for corrosion protection, where specified, shall be performed before insulation is applied.

7. Painting of piping for color coding, where specified, shall be performed after insulation is applied.
8. Insulate each piping section with single thickness full-length units of insulation, with a single cut piece to complete the run where a fitting is encountered. Do not use cut pieces or scraps abutting each other.
9. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
10. Extend piping insulation without interruptions through walls, floors, and similar piping penetrations, except where otherwise specified.
11. Insulation on unions, flanges, valves, strainers, expansion joints, pump impeller housings and other equipment requiring accessible servicing shall be removable and reusable without damage. Items requiring periodic attention shall have covers and/or casings to contain the insulation.
12. All "cold" piping systems shall be insulated with type and thickness of material herein specified and shall have a continuous vapor retarder through all fittings, hangers, supports and sleeves.
13. In cold systems flanges, unions, valves, etc., shall be covered with an oversized pipe insulation section sized to provide the same thickness as on the main piping section. An oversized insulation section shall be used to form a collar between two insulation sections with low-density blanket insulation being used to fill gaps. Jacketing shall match that used on main piping system. Rough cut ends shall be coated with suitable weather and/or vapor resistant mastic as required by the system location and service. All valve stems must be sealed with caulking that allows free movement of the stem but provides a seal against moisture incursion.
14. In hot system flanges, unions, valves, etc., shall be left exposed; insulation ends shall be tapered and sealed to allow bolts to be removed or other required access.
15. The installation of cold piping systems shall use oversize (outside the thickness of the insulation) pipe hangers.
 - a. Piping systems 3" and smaller, the Insulation Contractor shall replace temporary wood blocking with insulation of thickness as scheduled in this section of the specification. Metal pipe shields shall be placed between the pipe hanger and the insulation.
 - b. Piping systems 4" and larger, the Insulation Contractor shall replace the temporary wood blocking with high density pre-formed insulation (i.e. calcium silicate, cellular glass) inserts with suitable characteristics for the weight, temperature and application and insulation protection shields at each hanger. The specified insulation should stop and start at the insert at the hanger locations. The insert shall be wrapped with vapor barrier jacketing. Circumferential joints shall be taped with vapor barrier tape and coated with vapor barrier sealant. B-Line, or equivalent, figure B-3380 through B-3384, 360 deg. calcium silicate insert/shields and figure B-3153 protection shields may be used or equivalent may be field fabricated per details submitted for approval.
 - c. If in the event pipe hangers are not oversized, this Contractor shall notify the Engineer and the Contractor(s) who provided and/or installed hangers. Hangers shall be corrected before pipe is insulated.
 - d. Where size on size hangers have been approved by the Engineer in writing for use in special situations, the insulator shall insulate the hanger and hanger rod with ½" Type F insulation. Pipe insulation shall terminate at each side of the hanger and have vapor barrier end joint butt strips. Hanger insulation shall overlap pipe insulation a minimum of 4" on each side of the hanger and secured to the pipe

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- insulation with contact adhesive. Hanger rods shall be insulated for a minimum of 12" secured to the rod with contact adhesive and the end sealed with a bead of caulk.
- e. The Contractor shall adjust hangers after the insulation and pipe shields have been installed to provide an evenly supported piping system. No hanger shall bear the entire weight or not carry any weight of piping system.
16. Special requirements for fiberglass pipe insulation:
- a. Fiberglass pipe insulation, All Service Jacket/Self Sealing Lap (ASJ w/SSL) type, shall be installed with laps positioned to shed water, position at either 10 o'clock or 2 o'clock and shall not be visible to view. End joint butt strips shall be installed on all piping with ½" adhesive to adhesive overlap.
- b. For piping systems using fiberglass insulation, the fittings shall be insulated with: double thickness molded fiberglass fittings, or preformed cellular glass fittings secured with twine or wire; or with flexible elastomeric foamplastic; at the Contractor's option. The pre-molded PVC fitting covers shall be installed over the fiberglass inserts and secured with SS tacks. Victaulic fittings or couplings shall be insulated with sheet elastomeric foam plastic insulation formed to the fitting and formed "collars" over all couplings encountered.
- c. For piping systems using fiberglass insulation, butt joints in hot piping shall be made with 2" wide vapor barrier tape over butt joints. Butt joints in cold piping shall be made with a wet coat of vapor barrier lap cement on butt joints and seal joints with 2" vapor barrier tape. All pipe insulation ends shall be tapered and sealed.
- d. On "cold" applications only, the following additional requirements shall apply: the premolded fittings shall be sealed with an approved vapor barrier retardant prior to installing the jacket materials. Premolded PVC fitting covers shall then be installed over the premolded inserts, all joints shall be sealed with vapor barrier cement and 2" vapor barrier tape on lap joints. Premolded stainless steel or aluminum fitting covers shall be installed per the manufacturer's instructions and a bead of clear silicon caulk applied to all joints. Straight lengths of insulation abutting all fittings shall have both ends sealed with vapor barrier cement to prevent "wicking" or moisture migration. At a maximum of twenty-one foot (21') intervals, joining ends of the butt joints shall be sealed with vapor barrier cement prior to butting together to prevent "wicking" or moisture migration.
17. For piping systems using elastomeric foamplastic insulation, joints and seams shall be sealed with manufacturer's recommended contact adhesive. Fittings shall be insulated from segments fabricated from pipe insulation or sheet material, secured and sealed with contact adhesive. Termination points and ends shall be sealed to the pipe to prevent backflow of condensation on the inside of the insulation. Any piping outdoors or otherwise exposed to UV or ozone provide two (2) coats of WB Armaflex or equivalent.
18. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.
- G. Field-applied Insulation for Equipment
1. Manufactured equipment (i.e. air handling equipment, terminal units, air device plenums, etc.) requiring insulation shall be specified in the respective equipment specifications to be factory insulated with internally applied liner or double wall casing.
- H. Field-applied Insulation for Ductwork
1. Ductwork systems shall be insulated in accordance with the insulation schedules. Insulate each duct section with single thickness full length pieces. Do not use scraps abutting each other.
-

2. Extend insulation without interruptions through walls, floors, and similar penetration, except where otherwise specified.
 3. "Cold" duct systems shall have insulation with a continuous vapor retarder through all fittings, hangers, supports, air devices, fire dampers, duct mounted coils, dampers, and other devices in the ductwork system, etc.
 4. In "cold" duct systems, using rigid board or sheet elastomeric foam insulation, support angles, stiffener angles, ductmate flanges, etc. they shall be covered with an oversized insulation strip sized to provide the same insulation thickness as on the duct. Provide a minimum of 2" of overlap on each side of the obstruction.
 5. Board insulation shall be properly cut and dry fitted to the surface to be insulated. Edges shall be neat and clean cut. No intermediate cut pieces shall be allowed on the bottom and sides of the ductwork. Insulation board shall be secured in place using mechanical fasteners such as welded pins or speed clips. Locate not less than 3" from each edge or corner and approximately 12" on centers on all sides. There shall be a minimum of two (2) rows of pins on the bottom of the duct and one (1) on the sides. Additional pins may be needed on the bottom to prevent sagging. All seams, joints, penetrations and breaks in the vapor retarder jacket shall be sealed with pressure sensitive tape matching insulation facing. Edges shall be provided with 28 ga. 1" x 1" aluminum corner beading properly secured and shall have the same facing material as the insulation board.
 6. Flexible duct wrap insulation shall be cut properly and fitted to "stretchout" dimensions and a 2" piece of insulation removed from the facing at the end of the piece to form an overlapping staple and tape flap. Insulation shall be installed with facing outside so tape flap overlaps facing at the other end. Insulation shall be butted tightly. Seams shall be stapled on 6" centers with outward clinching staples. Adjacent sections of duct wrap insulation shall be butted tightly with the 2" tape flap overlapping and stapled. For horizontal oval ducts over 30" wide, duct wrap insulation shall be secured additionally to the bottom of the duct with mechanical fasteners such as pins and speed clip washers spaced on 18" centers to prevent sagging. All seams, joints, tears, punctures and other penetrations in the vapor retarder jacket shall be sealed with FRK backing pressure sensitive tape.
 7. Stop and point insulation around access doors and damper operators to allow operation without disturbing insulation.
 8. Where a duct run changes from interior lining to exterior application (or vice versa), there shall be a 6" overlap of insulation.
 9. In "cold" duct system with internal duct insulation, with 1 1/2 " thickness flexible duct wrap, insulate air devices, fire dampers, duct mounted coils, dampers, and other devices in the ductwork system that are not internally insulated.
- I. PVC Pipe Insulation Plenum Fire Wrap
1. Provide 1/2 inch minimum thickness fire resistant blanket wrap consisting of inorganic blanket encapsulated with a scrim-reinforced aluminum foil and overlap seam to provide a flexible, non-combustible enclosure for cables and PVC non-plenum rated pipe in return air plenums as tested to UL 910.
 2. Plenum Wrap shall be tested in accordance with the following:
 - a. ASTM C 411, ASTM C 518, ASTM E 84, ASTM E 136, and UL 910
 - 1) Maximum Flame Spread (Ft.) 0.01
 - 2) Maximum Smoke (Optical Density) 0.01
 - 3) Average Smoke (Optical Density) 0.00
 - b. Surface Burning Characteristics (ASTM E 84)
 3. Cut Fire Barrier Plenum Wrap to a length sufficient to wrap completely around the perimeter of the pipe, plus provide a longitudinal overlap of not less than 1 inch and an

overlap of 1 inch, minimum, over the adjacent wrap section. Use aluminum foil tape to seal cut edges of the blanket. Temporarily secure Plenum Wrap in place using 3/4 inch wide filament tape. Install minimum 1/2 inch wide by 0.015 inch (28 gauge) thick stainless steel metal banding with stainless steel metal band clamp or 16 gauge galvanized tie wire around the Plenum Wrap to hold it in place. Place the bands or tie wires 1/4 inch from each edge of the blanket and at the midpoint of the blanket, 11-3/4 in. on center. Tension the banding or tie wire to hold the Plenum Wrap snugly in place, compressing the foil but not cutting the foil.

4. PVC Piping Insulation Plenum Fire Wrap shall be 3M Fire Barrier Plenum Wrap 5A or approved equivalent.

J. Field-applied Protective Finish Jackets

1. Aluminum stainless steel jackets [with moisture barrier] shall be cut and fitted to size required.
2. Fold a 1/2" safety edge on exposed side, roll to diameter required and secure with 1/2" x 0.020" aluminum or 1/2" x 0.015" stainless steel bands respectively on 9" centers (4 bands per 3 foot section of jacketing).
3. Provide appropriate seals, and shed water toward low end of pitched piping.
4. Install lap on top quadrant (2 or 10 o'clock position) of outside diameter of insulation and line up bands and seals to present neat and workmanlike appearance.
5. Fitting covers shall be consistent with piping insulation jacketing.
6. Secure in place with SS screws or banding.
7. Seal with approved caulking.
8. Sharp edges shall be turned under or otherwise protected.

K. Field-applied Protective Finish Jackets

1. PVC jacketing for pipe shall be applied with the SSL lap positioned properly to facilitate solvent welding of the seam.
2. PVC fitting covers shall be installed with proper watershed and all joints sealed with solvent welding.
3. Penetrations in the jacketing for hangers, supports and other openings shall be sealed with silicone caulk to be weather, vapor and watertight.

L. Field-applied Self-Adhesive Jackets

1. Ensure that all surfaces are clean and dry; free from dust, oil and grease/silicone.
2. Install per manufacturer's instructions.
3. When applying, partly peel back and crease the liner so enough adhesive is available to attach the jacketing in the correct position.
4. Apply with 3" overlap to provide weatherproof seal.
5. Position jacket so the edge of the sealing lap faces down.

3.3 CLEANING AND PROTECTION

A. Clean

3.4 INSULATION MATERIAL SCHEDULE I-1 (HOT AND COLD PIPING)

A. Chilled water supply and return piping

1. 2" and smaller

- a. Type PI1, PH, or F1
 - b. Thickness – 3/4"
 - 2. 2-1/2" through 5"
 - a. Type PI1, PH, or F1
 - b. Thickness - 1"
 - 3. 6" and larger
 - a. Type PI1 or PH
 - b. Thickness - 1-1/2"
- B. Hot water (140°F and less) supply and return
 - 1. 1-1/4" and smaller
 - a. Type GF1 or F1
 - b. Thickness - 1"
 - 2. 1-1/2" and larger
 - a. Type GF1 or F1
 - b. Thickness - 1-1/2"
- C. Hot water (141°F – 200°F) supply and return
 - 1. 1-1/4" and smaller
 - a. Type GF1 or F1
 - b. Thickness - 1-1/2"
 - 2. 1-1/2" and larger
 - a. Type GF1 or F1
 - b. Thickness - 2"
- D. Combination chilled/hot (heating) water supply and return piping
 - 1. All sizes
 - a. Type GF1
 - b. Thickness - 1-1/2"
- E. Low pressure steam condensate return piping including condensate pump discharge
 - 1. 1-1/4" and smaller
 - a. Type GF1
 - b. Thickness - 1-1/2"
 - 2. 1-1/2" and larger
 - a. Type GF1
 - b. Thickness - 2"
- F. Low pressure (15# and less) steam supply
 - 1. 3" and smaller
 - a. Type GF1
 - b. Thickness - 2-1/2"
 - 2. 4" and larger
 - a. Type GF1
 - b. Thickness - 3"
- G. Steam supply (16# to 120#)
 - 1. 3/4" and smaller
 - a. Type GF1
 - b. Thickness - 3"
 - 2. 1" and 1-1/4"

- a. Type GF1
 - b. Thickness - 4"
 - 3. 1-1/2" and larger
 - a. Type GF1
 - b. Thickness - 4-1/2"
- H. Steam supply (121# and greater)
 - 1. 3/4" and smaller
 - a. Type GF1
 - b. Thickness - 4-1/2"
 - 2. 1" and larger
 - a. Type GF1
 - b. Thickness - 5"
- I. Low Temp Chilled Water supply and return piping: 0 to 40 degrees F.
 - 1. 2" and smaller
 - a. Type F1
 - b. Thickness - 1-1/2"
 - 2. 2-1/2" and larger
 - a. Type PI1, PH, or F1
 - b. Thickness - 2"
- J. Electrically heat traced piping
 - 1. All sizes
 - a. Type as specified for the system.
 - b. Thickness - 1-1/2"
- K. Domestic water- hot, hot recirc.
 - 1. 2" and smaller
 - a. Type GF1 or F1
 - b. Thickness - 1"
 - 2. 2-1/2" and larger
 - a. Type GF1
 - b. Thickness - 1-1/2"
- L. Domestic water-cold
 - 1. All sizes
 - a. Type F1 or GF1
 - b. Thickness - 1/2"
- M. Storm water from the roof drain to the first floor level below the roof. Thereafter, all horizontal piping only and related elbows to vertical.
 - 1. All sizes
 - a. GF1
 - b. Thickness - 1"
- N. Storm water roof drain body
 - 1. All sizes
 - a. F2
 - b. Thickness - 1/2"

- O. Refrigeration Piping:
 - 1. Suction - 2" and smaller
 - a. Type F1
 - b. Thickness – 3/4"
 - 2. Suction 2-1/2" and larger"
 - a. Type F1
 - b. Thickness – 1"
 - 3. Hot gas/discharge, all sizes where piping is 8'-0" or less AFF
 - a. Type F1
 - b. Thickness – 3/4"
- P. Condensate Drain Lines:
 - 1. All sizes except air handling units in Mechanical Rooms where drain line is 2'-0" or less in total length and located at the Mechanical Room floor.
 - a. Type F1
 - b. Thickness – 1/2"
- Q. Waste Piping and Floor Drains:
 - 1. All sizes, piping above grade serving floor drains, hub drains, indirect cabinets, etc., that receive condensate from cooling coils. Insulate piping to where it connects to main waste pipe.
 - a. Type F1
 - b. Thickness – 1/2"
- R. Sump Pump Discharge Lines:
 - 1. All sizes
 - a. Type F1
 - b. Thickness – 1/2"
- S. Fittings (hot and cold):
 - 1. All sizes
 - a. Molded/preformed fittings, matching insulation type, secured in place with twine or tape, seal all "cold" applications prior to installing jacket material.
 - b. Thickness – matching adjacent piping
- T. Unions, flanges, valves: (cold piping):
 - 1. All sizes
 - a. Type F1
 - b. Thickness – matching adjacent piping
 - c. Form external collar, minimum 1" overlap on adjacent insulation. Use adhesive to secure in place and maintain vapor barrier.
- U. Unions, flanges (hot piping):
 - 1. All sizes
 - a. No insulation.
- V. Valves (hot piping):
 - 1. All sizes, insulate valve body only
 - a. Type: match adjacent piping
 - b. Thickness – matching adjacent piping

- W. Joints, lines subject to condensation:
 - 1. All sizes
 - 2. Seal longitudinal laps of jacket with adhesive and wrap butt joints between sections with 2" wide tape.

3.5 INSULATION MATERIAL SCHEDULE I-2 (COLD EQUIPMENT)

- A. Chilled (cold) surfaces, not factory insulated, interior application
 - a. Type F2
 - b. Thickness – 3/4"
- B. Air separator (Rolairtrol unit)
 - a. Type F2
 - b. Thickness - 1"
- C. Pump impeller housing
 - a. Type F2
 - b. Thickness - 1"
- D. Water boxes of chilled water heat exchangers
 - a. Type F2
 - b. Thickness - 1"
- E. Fittings:
 - 1. All sizes
 - a. Type F1
 - b. Thickness - 1"
- F. Unions, flanges, valves:
 - 1. All sizes
 - a. Type F1 or F2
 - b. Thickness - 1"
- G. Joints and seams: Seal with Armstrong 520 adhesive.
- H. Finish, interior: No additional finish required.
- I. Finish, exterior: Seal with (2) coats of WB Armaflex
- J. Hangers, supports: Outside insulation with continuous vapor barrier. (This may be difficult to accomplish, particularly if equipment is heavy. If hanger or support is in direct contact with equipment, insulate immediate support and connecting member(s) for length of 12" away.)

3.6 INSULATION MATERIAL SCHEDULE I-3 (HOT EQUIPMENT)

- A. Heat exchangers
 - 1. Type: GF2, or GF1 or GF1A for round surfaces
 - 2. Thickness - 2"
- B. Hot thermal storage tanks

-
1. Type: GF2, or GF1 or GF1A for round surfaces
 2. Thickness - 2"
- C. Boiler feed water storage tanks
1. Type: GF2, or GF1 or GF1A for round surfaces
 2. Thickness - 2"
- D. Steam condensate receivers
1. Type: GF2, or GF1 or GF1A for round surfaces
 2. Thickness - 2"
- E. Condensate and flash tanks
1. Type: GF2, or GF1 or GF1A for round surfaces
 2. Thickness - 2"
- F. Hot water pump impeller housings
1. Type: GF2, or GF1 or GF1A for round surfaces
 2. Thickness - 2"
- G. Air separator (Rolairtrol unit)
1. Type: GF2, or GF1 or GF1A for round surfaces
 2. Thickness - 2"
- H. Domestic hot water storage tanks
1. Type: GF2, or GF1 or GF1A for round surfaces
 2. Thickness - 2"
- I. Boiler and water heater breechings below 450 degrees F.
1. Type: GF2, or GF1 or GF1A for round surfaces
 2. Thickness - 2"
- J. Flanges: No insulation.
- K. Attachment:
1. Secure rigid board with welded pins on 12" centers.
 2. Secure with $\frac{3}{4}$ " x 0.020" SS bands on 12" centers. Fit ends of tanks and irregular surfaces by segmenting or scoring board and wiring into place.
- L. Joints:
1. Point and fill-in all joints and voids with insulating cement or fill-in all joints and voids by stuffing with mineral wool.
- M. Jacket:
1. 0.016" smooth aluminum jacket with moisture barrier, secured with $\frac{1}{2}$ " x 0.015" SS bands on 9" centers and SS sheet metal screws.
- 3.7 INSULATION MATERIAL SCHEDULE I-4 (DUCTWORK 0 to 250 degrees F)<TYPICAL FOR JOBS WITHOUT INTERNAL DUCT LINING SPECIFIED IN DIVISION 24> EDIT TO SUIT PROJECT REQUIREMENTS>Unconditioned Spaces and Mechanical Rooms.
1. Shall have minimum installed R-value: R-6
-

2. Rectangular Supply Air, Heated or Cooled Make-up/Ventilation Air
 - a. Type: GF2
 - b. Thickness – 1-1/2”
3. Round or Oval Supply Air, Heated or Cooled Make-up/Ventilation Air
 - a. Type: GF3
 - b. Thickness - 2”
4. VAV box coil return bends, Duct mounted coils
 - a. Type: GF3
 - b. Thickness - 2”
5. Rectangular Return Air, Outdoor Air, Mixed Air, associated plenums and Filter Sections
 - a. Type: GF2
 - b. Thickness – 1-1/2”
6. Round or Oval Return Air, Outdoor Air, and Mixed Air
 - a. Type: GF3
 - b. Thickness - 2”
7. Rectangular Relief or Exhaust air connected to energy recovery devices
 - a. Type: GF2
 - b. Thickness – 1-1/2”
8. Round or Oval Relief or Exhaust air connected to energy recovery devices
 - a. Type: GF3
 - b. Thickness - 2”
9. Relief Air N/A
10. Exhaust Air N/A

B. Conditioned Spaces and Return Air Plenums.

1. Shall have minimum installed R-value: R-4
2. Rectangular Supply Air, Heated or Cooled Make-up/Ventilation Air
 - a. Type: GF2
 - b. Thickness - 1”
3. Round or Oval Supply Air, Heated or Cooled Make-up/Ventilation Air
 - a. Type: GF3
 - b. Thickness - 1”
 - c. (Refer to Division 24 and drawings for location of K-27 double wall ducts)
4. VAV box coil return bends, Duct mounted coils
 - a. Type: GF3
 - b. Thickness - 1”
5. Return Air N/A
6. Rectangular Return Air, Outdoor Air, Mixed Air, associated plenums and Filter Sections
 - a. Type: GF2
 - b. Thickness - 1”
7. Round or Oval Return Air, Outdoor Air, and Mixed Air
 - a. Type: GF3
 - b. Thickness - 1”
 - c. (Refer to Division 24 and drawing for location of K-27 double wall ducts)
8. Relief Air N/A
9. Exhaust Air N/A

C. Outside of the Building Insulation Envelope

1. Shall have minimum installed R-value: R-8

2. Rectangular Supply Air, Heated or Cooled Make-up/Ventilation Air
 - a. Type: PI2
 - b. Thickness - 2"
 - c. Provide tapered insulation on top surface to prevent ponding on ductwork.
 - d. Jacket: Self-adhesive, field-applied outdoor jacket
3. Duct mounted coils
 - a. Type: PI2
 - b. Thickness - 2"
 - c. Provide tapered insulation on top surface to prevent ponding on ductwork.
 - d. Jacket: Self-adhesive, field-applied outdoor jacket
4. Rectangular Return Air
 - a. Type: PI2
 - b. Thickness - 2"
 - c. Provide tapered insulation on top surface to prevent ponding on ductwork.
 - d. Jacket: Self-adhesive, field-applied outdoor jacket
5. Round or Oval Supply Air, Heated or Cooled Make-up/Ventilation Air
 - a. Type: GF1A
 - b. Thickness - 2"
 - c. Jacket: Self-adhesive, field-applied outdoor jacket
6. Round or Oval Return Air
 - a. Type: GF1A
 - b. Thickness - 2"
 - c. Jacket: Self-adhesive, field-applied outdoor jacket
7. Outdoor Air and Mixed Air N/A
8. Outdoor Air and Mixed Air Plenums, and Filter sections N/A
9. Relief Air N/A
10. Exhaust Air N/A

D. Fire Rated Insulation Applications

1. Rectangular Ductwork
 - a. Type: FR1
2. Round Ductwork
 - a. Type FR2

<OR>

3.8 INSULATION MATERIAL SCHEDULE I-4 (DUCTWORK 0 to 250 degrees F) TYPICAL FOR JOBS WITH INTERNAL DUCT LINING SPECIFIED IN DIVISION 24> <EDIT TO SUIT PROJECT REQUIREMENTS>Outdoor Air, Return Air and Mixed Air Plenums, and Filter sections

- a. Type: GF2
- b. Thickness - 1"

B. Round and oval Supply Air

- a. Type: GF3
- b. Thickness - 1-1/2"
- c. (Refer to Division 24 and drawings for location of K-27 double wall ducts)

C. VAV box coil return bends

- a. Type: GF3

-
- b. Thickness – 1-1/2”
 - D. Outside Air and Mixed Air ducts
 - a. Type: GF3
 - b. Thickness – 1”
 - E. Outside of the Building Insulation Envelope
 - 1. Rectangular Supply Air, Heated or Cooled Make-up/Ventilation Air
 - a. Type: PI2
 - b. Thickness - 2”
 - c. Provide tapered insulation on top surface to prevent ponding on ductwork.
 - d. Jacket: Self-adhesive, field-applied outdoor jacket
 - 2. Round or Oval Supply Air, Heated or Cooled Make-up/Ventilation Air
 - a. Type: GF1A
 - b. Thickness - 3”
 - c. Jacket: Self-adhesive, field-applied outdoor jacket
 - d. (Refer to Division 24 and drawings for location of K-27 double wall ducts)
 - 3. Duct mounted coils
 - a. Type: PI2
 - b. Thickness - 2”
 - c. Provide tapered insulation on top surface to prevent ponding on ductwork.
 - d. Jacket: Self-adhesive, field-applied outdoor jacket
 - 4. Rectangular Return Air
 - a. Type: PI2
 - b. Thickness – 1-1/2”
 - c. Provide tapered insulation on top surface to prevent ponding on ductwork.
 - d. Jacket: Self-adhesive, field-applied outdoor jacket
 - 5. Round or Oval Return Air
 - a. Type: GF1A
 - b. Thickness - 2”
 - c. Jacket: Self-adhesive, field-applied outdoor jacket
 - d. (Refer to Division 24 and drawings for location of K-27 double wall ducts)
 - 6. Outdoor Air and Mixed Air N/A
 - 7. Outdoor Air and Mixed Air Plenums, and Filter sections N/A
 - 8. Relief Air N/A
 - 9. Exhaust Air N/A
 - F. Fire Rated Insulation Applications
 - 1. Rectangular Ductwork
 - a. Type: FR1
 - 2. Round Ductwork
 - a. Type FR2
- 3.9 JACKET MATERIAL SCHEDULE I-5
- A. Finish insulation with factory or field application for respective locations as follows:
 - B. Dry, low abuse (indoor): Concealed, not exposed to view; mechanical equipment rooms; exposed, finished spaces.
 - 1. Pipe: ASJ jacket.
-

2. Pipe Fittings: Pre-molded PVC covers.
 3. Duct:
- C. High abuse area: Exposed vertical risers in all Storage Rooms, Janitor Closets; Exposed, unfinished spaces. <Describe Additional Areas>
1. Pipe: 304 [316] Stainless steel jacket, smooth, 0.010 inch thick, with seam away from abusive force. Apply to height of 8 feet.
 2. Pipe Fittings: Formed stainless steel covers.
 3. Duct:

- D. Outdoors: All
1. Pipe: Aluminum jacket, smooth
 2. Pipe Fittings: Formed aluminum covers.
 3. Duct:
 4. Thickness:

Outer Insulation Diameter (in)	Min. Aluminum Jacketing Thickness (in)	
	Rigid Insulation	Non-Rigid Insulation
≤8	0.016	0.016
Over 8 thru 11	0.016	0.020
Over 11 thru 24	0.016	0.024
Over 24 thru 36	0.020	0.032
>36	0.024	0.040

- E. Outdoors: All
1. Pipe: Stainless Steel, smooth
 2. Pipe Fittings: Formed aluminum covers.
 3. Duct:
 4. Thickness:

Outer Insulation Diameter (in)	Min. Stainless Steel Jacketing Thickness (in)
≤8	0.010
Over 8 thru 11	0.010
Over 11 thru 24	0.010
Over 24 thru 36	0.016
>36	0.020

- A. Outdoors: All
1. Pipe: Aluminum jacket, smooth
 2. Pipe Fittings: Formed aluminum covers.
 3. Duct:

B.

- C. Wet areas (indoor):
1. Pipe: PVC cover, 30 mills thick
 2. Pipe Fittings: Pre-molded PVC covers.
 3. Duct:

END OF SECTION 20 20 25

SECTION 21 00 00 – FIRE PROTECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provisions and conditions cited in this Section shall apply to Work for other sections of Divisions 21 of these Specifications.
 - 1. Section 21 00 10 – Fire Protection Design
 - 2. Section 21 00 20 – Piping and Accessories
 - 3. Section 21 00 30 – Wet Pipe Sprinkler System
 - 4. Section 21 00 40 – Dry Pipe Sprinkler System
- C. The following section of the Specifications apply to Work under this Section
 - 1. Division 20 - Basic Mechanical Conditions and Basic Mechanical Material and Methods
 - 2. Division 26 - Electrical
 - 3. Division 28 – Electronic Safety and Security

1.2 SUMMARY

- A. Section Includes:
 - 1. Wet pipe systems for areas not subject to freezing.
 - 2. A dry pipe system, including an air compressor, for areas subject to freezing, and where indicated on the drawings.
 - 3. All required fire department connections,
 - 4. Water supply including backflow prevention devices, vaults, meter, detector check, post indicating valves, etc

1.3 QUALITY ASSURANCE

- A. Work for this Section of the Specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Division 20.
- B. All operable devices and features of sprinkler system, accessories, equipment and specialties provided for in the Scope of Work of this Section shall be operated and proved to function satisfactorily for a period of forty-eight (48) hours. Adjust, balance, lubricate as required, and instruct the Owner in the proper operation and maintenance of each device.
- C. Sprinkler system, equipment and specialties shall be protected against damage in the period between installation and acceptance. Any item damaged shall be removed, repaired and/or replaced at no additional compensation.
- D. Place plugs in the ends of uncompleted piping at the end of each day or when work stops.

1.4 ACTION SUBMITTALS

- A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

1.5 CLOSEOUT SUBMITTALS

- A. Refer to General Conditions and Division 20.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 21 00 00

SECTION 21 00 10 – FIRE PROTECTION DESIGN

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Performance Requirements
 - 2. Water Supply
 - 3. Delegated Design.
- B. Related Requirements:
 - 1. Section 21 00 00 FIRE PROTECTION SYSTEMS

1.2 REFERENCES

- A. Applicable requirements of the current and accepted edition of the following industry standards, codes and specifications shall apply to the Work for Division 21
 - 1. ANSI American National Standards Institute
 - 2. National Fire Protection Association (NFPA) 13, [2019].
 - 3. National Fire Protection Association (NFPA) 14, [2019].
 - 4. National Fire Protection Association (NFPA) 20, [2019]. The Local Authority having jurisdiction.
 - 6. UL Underwriters Laboratory, Inc.
 - 7. [Owner's Insurance carrier – FM Global]

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Submittal drawings shall show lights, ducts, and pipes indicating all necessary rises and drops in sprinkler piping required for routing. Drawings shall be of a minimum of the same scale as the contract documents [1/8" = 1'-0" scale, 1/4" = 1'-0" scale.]. A 1/4" scale drawing of the service entrance and an elevation of the service entrance shall be required. A sprinkler riser diagram showing all control valves, test connections, supervisory switches, and drains shall be required.
- C. The "layout" submittals shall be provided as PDF drawings of the piping layout.
- D. Any pipe sizing or hydraulic calculations performed prior to the Contractor receiving the "layout" submittal with the 'approved stamp' of the Engineer shall be at the Contractor's own risk. Any design changes resulting in resizing pipe and/or revising hydraulic calculations will be done at no cost to the Owner.
- E. The "working drawing" submittals shall be provided as PDF drawings of the piping layout and include hydraulic calculations. Calculations shall include peaking information for each area

calculated. The hydraulic calculation used for the system design shall be clearly identified from all other hydraulic calculations and should show the safety factor the designed system has relevant to the available water test pressure.

- F. Hydraulic calculations shall include: actual pipe internal diameters and coefficients of materials approved in the “layout” submittal; design density; remote area size; and area per sprinkler.
- G. The Contractor shall not pursue any approvals or interpretations of the design documents except through the office of the Architect/Engineer.
- H. All work shall meet the requirements of the Owner, authority having jurisdiction, [Owner's insurance underwriter], Architect and Engineer. These requirements may be greater than required by NFPA. Work shall not start prior to the Contractor receiving the “working drawing” shop drawings with the 'stamp' of the Engineer and approval from the authority having jurisdiction.
- I. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

1.4 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

1.6 FIELD CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
 - 1. Notify [Architect] [Construction Manager] [Owner] no fewer than [two] in advance of proposed interruption of sprinkler service.
 - 2. Do not proceed with interruption of sprinkler service without [Architect's] [Construction Manager's] [Owner's] written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Sprinkler system equipment, specialties, accessories, installation, and testing to comply with [NFPA 13] [and FM Global].
- C. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- D. High-Pressure Piping System Component: Listed for **[250-psig minimum] [300-psig]** working pressure.
- E. Pipe velocities shall not exceed 14 feet per second in any section of the piping system.

2.2 WATER SUPPLY

- A. The water supply shall be a connection to the [public, private, storage tank, etc.] water supply.
- B. [A new flow test witnessed by the Fire Marshal shall be conducted.]
- C. [Available fire-hydrant flow test records indicate the following conditions.]
 - 1. Date: <Insert test date>.
 - 2. Time: <Insert time> [a.m.] [p.m.]
 - 3. Performed by: <Insert operator's name> of <Insert firm>.
 - 4. Location of Residual Fire Hydrant R: <Insert location>.
 - 5. Location of Flow Fire Hydrant F: <Insert location>.
 - 6. Static Pressure at Residual Fire Hydrant R: <Insert psig>.
 - 7. Measured Flow at Flow Fire Hydrant F: <Insert gpm>.
 - 8. Residual Pressure at Residual Fire Hydrant R: <Insert psig>.
- D. [The riser for the existing _____ type system is located in _____ with a base of riser pressure calculation of _____ at _____ gpm. The connection to this system shall be located _____.]
- E. Design water pressure requirements shall include a minimum of [10-psi] safety factor. Where Authority having jurisdiction requires a higher safety factory it shall be used.

2.3 DELEGATED DESIGN

- A. Sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 20 percent, the 20% includes all losses through water-service piping, valves, and backflow preventers.
 - 2. Sprinkler Occupancy Light Hazard Areas:
 - a. Office and Public Areas
 - b. Corridors
 - c. Gymnasiums
 - d. Meeting Rooms
 - e. Locker Rooms
 - f. Multi-Purpose Rooms
 - g. Vestibules

- h. Stairs
 - i. Libraries – except large stack rooms
 - j. Hospitals
 - k. Churches
 - l. Unused Attics
 - 3. Sprinkler Occupancy Ordinary Hazard, Group 1 Areas:
 - a. Electrical Rooms
 - b. Mechanical Rooms
 - c. Elevator Equipment Room
 - d. Janitor's Closets
 - e. Storage Rooms – Stacks up to 8' in height
 - f. Laundry Rooms
 - g. Kitchens
 - 4. Sprinkler Occupancy Ordinary Hazard, Group 2 Areas:
 - a. Storage Rooms – Stacks up to 12' in height
 - b. Libraries – Large Stack Rooms
 - c. Shops – Wood Working or Metal Working
 - d. Stages
 - 5. The hazard protection level shall be increased as required for areas with hazardous materials, flammable and combustible liquids, or storage that requires additional protection per NFPA 13. The sprinkler design criteria for spaces with hazardous materials and/or flammable and combustible liquids shall be in accordance with NFPA 30 and the requirements for Extra Hazard occupancies of NFPA 13.
 - 6. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard: 0.10 gpm over 1500-sq. ft. area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
 - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
 - d. Special Occupancy Hazard: As determined by authorities having jurisdiction.
 - 7. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
 - a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
 - b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
 - 8. Reduction in design area shall be permitted for quick response sprinklers in accordance with NFPA 13.
- B. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and Division 21 "Seismic Protection".

PART 3 - EXECUTION

3.1 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.
- B. Report test results promptly and in writing.
- C. Contractor shall use manufacturer's pressure drop data in hydraulic calculations for flexible hoses piping connections where applicable and installed per the specifications.

3.2 INSTALLATION

- A. Provide a complete code compliant [and Factory Mutual (FM) approved] fire protection system as indicated by drawings and specifications related to this section.
- B. The "layout" shall be submitted to the Architect prior to performing hydraulic calculation, sizing pipes or seeking approvals from the authority having jurisdiction.
- C. The Architect/Engineer will review "layout" for aesthetics, and pipe routings for consistency with the construction documents.
- D. Minimum head spacing shall be as per [NFPA-13] additional heads may be required by the Architect/Engineer to create spacing that works with the reflected ceiling plans. Contractor shall layout any areas not shown on the plans with symmetry and "rhythm" in mind.
- E. Heads shall be on return bends and centered $\pm 1"$ for 2' x 2' ceiling tiles, or on quarter points $\pm 1"$ for 4' x 2' ceiling tiles.
- F. Contractor shall not scale the drawing, refer to architectural drawings for dimensions. Where the room dimension is at the maximum size listed for the sprinkler heads, install an additional row of sprinklers.
- G. Contractor shall locate heads in the field from the final wall locations. It shall be brought to the Architect's/Engineer's attention where the center of tile location exceeds the maximum distance of the sprinkler. Additional heads shall be added and the layout modified as directed by the Architect/Engineer at no additional cost to the Owner.
- H. All sets and rises shall be located above ceilings of adjacent spaces of rooms without ceilings as opposed to making the sets and risers in the exposed spaces.
- I. Inspector test connections and auxiliary drains shall be piped to spaces not occupied by building occupants, i.e., Mechanical Rooms, Storage Rooms, Janitor's Closets, etc.

END OF SECTION 21 00 10

SECTION 21 00 20 – PIPING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Backflow prevention device
 - 2. Fire department hose connections
 - 3. Flexible hoses
 - 4. Piping and Fitting Material
 - 5. Pressure gauges
 - 6. Supervisory switch
 - 7. Valves
 - 8. Water flow switch
- B. Related Requirements:
 - 1. Section 21 00 00 FIRE PROTECTION SYSTEMS

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

1.5 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. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of two (2) heads of each sprinkler head plus sprinkler wrench(es). Where this quantity is less than what is required by NFPA 13, provide additional heads in proportion to the types and temperatures utilized throughout the building.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 BACKFLOW PREVENTION DEVICE

- A. Double Check Valve Assembly with OS&Y gate shutoff valves.
 - 1. Assembly shall consist of two independently operated spring loaded cam-check valves, OS&Y resilient seated gate shut-off valves, and required test cocks.
 - 2. Basis of Design:
 - a. Watts Series 709
 - b. Ames Series 2000
 - c. Zurn Series 350
 - 3. Size: [6 inch] <insert size>
 - 4. Pressure Loss: [5 psig] <insert pressure> maximum, through middle one-third of flow range.
- B. Reduced Pressure Zone Assembly with OS&Y gate shutoff valves.
 - 1. Assembly shall consist of a pressure differential relief valve located in a zone between two positive seating cam-check assemblies, OS&Y resilient seated gate shut-off valves, and required test cocks.
 - 2. Basis of Design:
 - a. Watts Series 909
 - b. Ames Series 4000
 - c. Zurn Series 375
 - 3. Size: [6 inch] <insert size>
 - 4. Pressure Loss: [9 psig] <insert pressure> maximum, through middle one-third of flow range.

2.3 FIRE DEPARTMENT HOSE CONNECTIONS

- A. General Requirements:
 - 1. Furnish and install fire department connections (FDC) as indicated on the plans.
 - 2. Standard: UL 405.
 - 3. Pressure Rating: 175 psig minimum.
 - 4. Body Material: Cast Brass
 - 5. Body Type: Clapper
 - 6. Includes: Identification plate, caps, and chains
 - 7. Finish: [polished brass trim and wall plate], [polished chrome plated trim and wall plate], [rough brass or bronze], [rough chrome plated]

8. Hose Threads shall be according to NFPA 1963 and shall conform to the local fire department standards. Include extension pipe nipples, brass lugged swivel connections.
9. Labeling shall be ["AUTO SPRINKLER"], ["STANDPIPE - AUTO SPKR"], ["STANDPIPE"], ["DRY STANDPIPE"]

B. Flush Inlets:

1. Basis of Design:
 - a. Potter Roemer Series 5000
 - b. Guardian Series 6000
 - c. Elkhart Brass
 - d. American Fire Supply

C. Free Standing:

1. Basis of Design:
 - a. Potter Roemer Series 5000
 - b. Guardian Series 6200
 - c. Elkhart Brass model 15
 - d. American Fire Supply

D. Two-way Exposed Inlets:

1. Basis of Design:
 - a. Potter Roemer Series 5000
 - b. Guardian Series 6100
 - c. Elkhart Brass model 11
 - d. American Fire Supply

E. Storz Connection:

1. Croker 6300 Series
2. Potter Roemer 5795 with cap.

2.4 FLEXIBLE HOSES

A. General Requirements:

1. Standard: UL 1474
2. Factory leak tested, fully welded, stainless steel (1" minimum internal diameter) corrugated pressure hose and braided stainless steel outer jacket.
3. Mechanical fittings or O-rings shall not be installed/accepted.
4. Length: Maximum 48"
5. System shall be manufactured by Flexhead, a Division of Anvil International, no substitutions allowed.

2.5 STEEL PIPE AND FITTINGS

A. General Requirements:

1. Comply with requirements of this section for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
2. Manufacturers:
 - a. Anvil International, Inc.
 - b. Tyco Fire & Building Products

c. Victaulic Company

- B. Standard-Weight Schedule 40 Steel Pipe: Galvanized and black-steel pipe, ASTM A53/A53M, Pipe ends may be factory or field formed to match joining method.
- C. Schedule 10, Black-Steel Pipe: ASTM A135/A135M or ASTM A795/A795M, Schedule 10 in NPS 4 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.
- D. Steel Pipe Nipples: [Galvanized] [and] [black] steel, ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
- E. Steel Couplings: [Galvanized] [and] [uncoated] steel, ASTM A865/A865M, threaded.
- F. Gray-Iron Threaded Fittings: [Galvanized] [and] [uncoated] gray-iron threaded fittings, ASME B16.4, Class 125, standard pattern.
- G. Malleable- or Ductile-Iron Unions: UL 860.
- H. Cast-Iron Flanges: ASME 16.1, Class 125.
- I. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
 - 1. Pipe-Flange Gasket Materials: [AWWA C110, rubber, flat face, 1/8 inch thick] [ASME B16.21, nonmetallic and asbestos free] [or] [EPDM rubber gasket].
 - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
 - 2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.
- J. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.
 - 1. 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.
- K. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Pressure Rating: [175-psig] [250-psig] [300-psig] minimum.
 - 2. Grooved-End Fittings for Steel Piping: [Galvanized] [Painted] [Uncoated] grooved-end fittings, ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
 - 3. 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.
- L. The following types of fittings are prohibited: plain end couplings and fittings, saddle/mechanical/clamp branch tee, grooved flange rings, and grooved reducing couplings.

2.6 PRESSURE GAUGES

- A. General Requirements:
 - 1. Standard: UL 393
 - 2. Size: 1/4 NPT or larger
 - 3. Dial Size: 3-1/2 inch

4. Pressure Gauge Range: upper limit at least twice the normal working pressure

2.7 SUPERVISORY SWITCH

- A. General Requirements:
 1. Standard: UL 753
 2. Housing: Rust Resistant
 3. Switch mechanism: Form C contacts at 10A/120VAC or 2A/24VDC suitable for operation at 120-volt A.C. or 24-volt D.C.
 4. Tamper-proof.
 5. Manufacturer: Potter-Roemer model OSYSU-2 or equivalent

2.8 VALVES

- A. General Requirements:
 1. Valves shall be UL listed and FM approved.
 2. Minimum pressure rating: 175 psi.
 3. Listed for use in fire protection systems.
- B. OS&Y Gate Valves:
 1. Standard: UL 262
 2. Body and Bonnet Material: Cast or ductile iron
 3. Wedge: Cast or ductile iron
 4. Wedge Seat: Cast or ductile iron
 5. Stem: Brass or bronze
 6. Packing: Non-asbestos PTFE
 7. Supervisory Switch: External
 8. Gear Operator: Manual
 9. Position indicator
- C. Butterfly Valves:
 1. Standard: UL 1091
 2. Body Material: Cast or ductile iron [with nylon, EPDM, epoxy or polyamide coating].
 3. Seat Material: EPDM
 4. Stem: Stainless Steel
 5. Disc: Ductile iron
 6. Actuator: Manual gear
 7. Supervisory Switch: Internal.
 8. Body Design: [Lug or wafer] [Groove-end connections].
- D. Drain Valves:
 1. Standard: UL listed
 2. Type: MSS SP-80, Type 2
 3. Body Material: Forged brass or bronze
 4. Class: minimum 125
 5. End Connections: threaded or grooved-end
- E. Check Valves:
 1. Standard: UL 312

2. Type: Swing check.
3. Body Material: Cast iron, ductile iron, or bronze.
4. Clapper: Bronze, ductile iron, or stainless steel [with elastomeric seal].
5. Clapper Seat: Brass, bronze, or stainless steel
6. Hinge Shaft: Bronze or stainless steel
7. Hinge Spring: Stainless steel
8. End Connections: flanged or grooved-end
9. Where used on fire department connections, valve shall have integral ball drip

F. Flow Test and Drain Valves:

1. Standard: UL listed
2. Type: Ball valve with sight glass
3. Manufacturers: Guardian model # 9215 or equivalent

G. Post Indicator Valve:

1. Standard: UL 789.
2. Type: Adjustable Height
3. Body Material: Ductile iron
4. Bonnet: Ductile iron.
5. Bonnet/Body Coating: Fusion bonded epoxy coating.
6. Operation: Handwheel
7. Gate Material: Cast iron, EPDM coated.
8. Manufacturers:
 - a. Kennedy Valve model 2945A
 - b. Mueller model A-20806
 - c. Victaulic series 774
 - d. Or approved equal.

2.9 WATER FLOW SWITCH

A. General Requirements:

1. Standard: UL 346
2. Water Flow Detector: Electrically supervised
3. Type: Paddle-operated
4. Pressure: 250 psig
5. Installation: Horizontal or vertical
6. Switch Mechanisms: Form C contacts at 10A/120VAC or 2A/24VDC suitable for operation at 120-volt A.C. or 24-volt D.C.
7. Dust tight construction and tamper-proof
8. Manufacturers: Potter-Roemer model VSR-F or equivalent.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.
- F. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.
- G. Examine roughing-in for fire-suppression standpipe system to verify actual locations of piping connections before fire-department connection installation.
- H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, PIPING

- A. Hydrostatically test at not less than 200 psi for two (2) hours per NFPA 13.
- B. Provide retainer glands where flanged ductile iron pipe is installed at point of building entry.

3.3 INSTALLATION, BACKFLOW PREVENTION DEVICE

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install in accordance with requirements of plumbing and health department and authorities having jurisdiction.
- B. Install reduced pressure zone assemblies in proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.

3.4 INSTALLATION, FIRE DEPARTMENT HOSE CONNECTIONS

- A. Outlets and/or pump test connections shall match the type, finish, and appearance of fire department connections and be furnished by the same manufacturer.
- B. Provide with a UL 1726 ball drip installed at the low point of the piping at each check valve for fire-department connection.

3.5 INSTALLATION, WATER FLOW SWITCH

- A. Install on the sprinkler system as indicated and where required by NFPA.
- B. Detectors shall be mounted in accordance with the manufacturer's instructions.

- C. Detectors shall be designed to signal any flow of water that equals or exceeds 10 gpm.
- D. Detector switch mechanisms shall incorporate and instantly recycling pneumatic retard element with an adjustable range of 0 to 60 seconds.
- E. Detector shall be furnished and installed under this Section and wired complete under Division 26.

3.6 INSTALLATION, SUPERVISORY SWITCH

- A. Switch shall be installed on all indicating and zone shut-off valves.
- B. Switch shall be mounted so as not to interfere with the normal operation of the valve.
- C. Switch shall be adjusted to operate within two revolutions of the valve control or when the stem has moved no more than one-fifth of the distance from its normal position.
- D. Switch shall be arranged to cause a switch operation if the housing cover is removed or if the unit is removed from its mounting.
- E. Switch shall be furnished and installed under this Section and wired complete under Division 26.

3.7 INSTALLATION, VALVES

- A. Provide all necessary components including non-rising stem gate valve at post indicator valve location.
- B. Coordinate installation of post indicator valve with fire alarm monitoring circuit.
- C. 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.
- D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.
- E. Install valves in horizontal piping with stem at or above the pipe center.
- F. Install valves in position to allow full stem movement.
- G. Install valve tags. Install permanent identification signs indicating the portion of system controlled by each valve.

3.8 INSTALLATION, PRESSURE GAUGES

- A. Furnish and install pressure gauges at locations shown on plans and where required for flow testing.
- B. Each gauge shall have a shutoff valve and be arranged for draining without disturbing the gauge.

3.9 INSTALLATION, SPARE HEAD CABINET

- A. Furnish and install at the fire protection service entrance.

3.10 INSTALLATION, FLEXIBLE HOSES

- A. Provide flexible piping connections to sprinkler heads installed in ceilings, walls, or ducts.
- B. Straight hoses may be used where space allows.
- C. Ninety-degree elbow type hoses shall be used where space does not allow straight type.
- D. Provide brackets and mounting hardware required for installation.

3.11 INSTALLATION, UNDERGROUND PIPING

- A. Provide retainer glands where flanged ductile iron pipe is installed at point of building entry.
- B. Hydrostatically test underground piping at not less than 200 psi for two (2) hours per NFPA 13, Section 8-2.2.

3.12 CLEANING AND PROTECTION

- A. Clean

3.13 PIPING SCHEDULE, UNDERGROUND

- A. General Requirements:
 - 1. Comply with requirements of this section for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
 - 2. Manufacturers:
 - a. Anvil International, Inc.
 - b. Tyco Fire & Building Products
 - c. Victaulic Company
- B. The following types of fittings are prohibited: plain end couplings and fittings, saddle/mechanical/clamp branch tee, grooved flange rings, and grooved reducing couplings.
- C. Size: All below grade.
 - 1. Pipe: Ductile iron.
 - 2. Fitting: Ductile iron.
 - 3. Joints: Mechanical with restrained joints.

END OF SECTION 21 00 20

SECTION 21 00 30 – WET PIPE SPRINKLER SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wet pipe sprinkler system
 - 2. Sprinkler heads
- B. Related Requirements:
 - 1. Section 21 00 00 FIRE PROTECTION SYSTEMS

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 SPRINKLER HEADS

- A. General Requirements:
 - 1. Sprinkler heads shall be UL listed and FM approved.
 - 2. Type: Quick response, liquid in glass bulb.
 - 3. Minimum Pressure: 175 psi
 - 4. Minimum orifice: ½ inch, ½” inch NPT
 - 5. Minimum K-factor: 5.65

6. Sprinklers with orifice larger than $\frac{1}{2}$ inch shall be $\frac{3}{4}$ inch NPT.
- B. Concealed Sprinklers:
 1. Cover plate: Adjustable White
 2. Manufacturer:
 - a. Viking model Horizon Mirage
 - b. Tyco model RF-II
 - c. Reliable model G4QR.
- C. Upright and Pendent Sprinklers:
 1. Unfinished spaces or concealed locations finish: Natural bronze
 2. Finished spaces Finish: White factory finish
 3. Manufacturer:
 - a. Viking model Microfast model M
 - b. Tyco model TY-FRB
 - c. Reliable model F1FR
- D. Sidewall Sprinklers:
 1. Type: Horizontal recessed
 2. Finish: White factory finish
 3. Manufacturer:
 - a. Viking model Microfast model M
 - b. Tyco model TY-FRB
 - c. Reliable model HSW-1

PART 3 - EXECUTION

3.1 INSTALLATION, PIPING

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

- F. Install sprinkler piping with drains for complete system drainage.
- G. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- H. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- I. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gauges with connection not less than 1/4 inch and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.
- J. Hydrostatically test piping at not less than 200 psi for two (2) hours per NFPA 13, Section 8-2.2.

3.2 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. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. 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.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

- I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- J. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 INSTALLATION, SPRINKLERS

- A. Sprinklers located in locations where they are likely to be damaged shall be furnished with wire guards.
- B. Sprinklers located in Natatoriums, showers, wet areas, or subject to corrosion shall be furnished with a corrosion resistant wax coating over polyester coated sprinkler.
- C. Sprinklers located beneath open grating shall be furnished with shields.
- D. Temperature range and response time shall be suitable for the location and the expected heat release.
- E. Within a space all sprinklers should be the same Temperature Range and Response Time to avoid “skipping”.

3.4 CLEANING AND PROTECTION

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.5 PIPING SCHEDULE:

- A. General Requirements:
 - 1. Comply with requirements of this section for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
 - 2. Manufacturers:
 - a. Anvil International, Inc.
 - b. Tyco Fire & Building Products
 - c. Victaulic Company

- B. The following types of fittings are prohibited: plain end couplings and fittings, saddle/mechanical/clamp branch tee, grooved flange rings, and grooved reducing couplings.
- C. Size: 2-1/2" and larger above grade.
1. Pipe: Schedule 10 Steel, "listed" lightweight steel with a minimum UL Corrosion Resistance Ratio of 1.0, or Schedule 40 steel at the Contractor's option.
 2. Fittings: Butt-welded, groove-end, forged steel flanges, thread-o-let, weld-o-let.
 3. Joints: Butt welded, groove-end couplings, flanged.
- D. Size: 2" and smaller above grade.
1. Pipe: Schedule 40.
 2. Fitting: Cast iron.
 3. Joints: Screwed, groove-end.

END OF SECTION 21 00 30

SECTION 21 00 40 – DRY-PIPE SPRINKLER SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Steel Pipe and Fittings
 - 2. Sprinkler heads
 - 3. Dry pipe sprinkler system
 - 4. Pre-action sprinkler system
 - 5. Air compressor
- B. Related Requirements:
 - 1. Section 21 00 00 FIRE PROTECTION SYSTEMS

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 STEEL PIPE AND FITTINGS

- A. General Requirements:
 - 1. Comply with requirements of this section for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2. Manufacturers:
 - a. Anvil International, Inc.
 - b. Tyco Fire & Building Products
 - c. Victaulic Company
- B. Standard-Weight Schedule 40 Steel Pipe: [Galvanized-] [and] [black-]steel pipe, ASTM A53/A53M, [Type E] <Insert type>, [Grade B] <Insert grade>. Pipe ends may be factory or field formed to match joining method.
- C. Schedule 10, Black-Steel Pipe: ASTM A135/A135M or ASTM A795/A795M, Schedule 10 in NPS 4 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.
- D. Steel Pipe Nipples: [Galvanized] [and] [black] steel, ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
- E. Steel Couplings: [Galvanized] [and] [uncoated] steel, ASTM A865/A865M, threaded.
- F. Gray-Iron Threaded Fittings: [Galvanized] [and] [uncoated] gray-iron threaded fittings, ASME B16.4, Class 125, standard pattern.
- G. Malleable- or Ductile-Iron Unions: UL 860.
- H. Cast-Iron Flanges: ASME 16.1, Class 125.
- I. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
 1. Pipe-Flange Gasket Materials: [AWWA C110, rubber, flat face, 1/8 inch thick] [ASME B16.21, nonmetallic and asbestos free] [or] [EPDM rubber gasket].
 - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
 2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.
- J. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.
 1. 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.
- K. Grooved-Joint, Steel-Pipe Appurtenances:
 1. Pressure Rating: [175-psig] [250-psig] [300-psig] minimum.
 2. Grooved-End Fittings for Steel Piping: [Galvanized] [Painted] [Uncoated] grooved-end fittings, ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
 3. 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.
- L. The following types of fittings are prohibited: plain end couplings and fittings, saddle/mechanical/clamp branch tee, grooved flange rings, and grooved reducing couplings.

2.3 SPRINKLER HEADS

- A. General Requirements:
 - 1. Sprinkler heads shall be UL listed and FM approved.
 - 2. Type: Quick response, liquid in glass bulb.
 - 3. Minimum Pressure: 175 psi
 - 4. Minimum orifice: ½ inch, ½" inch NPT
 - 5. Minimum K-factor: 5.65
 - 6. Sprinklers with orifice larger than ½ inch shall be ¾ inch NPT.
- B. Concealed Sprinklers:
 - 1. Cover plate: Adjustable White
 - 2. Manufacturer:
 - a. Viking
 - b. Tyco model DS Series
 - c. Reliable model G3A Dry Pendant Concealed.
- C. Upright Sprinklers:
 - 1. Unfinished spaces or concealed locations finish: Natural bronze
 - 2. Finished spaces Finish: White factory finish
 - 3. Manufacturer:
 - a. Viking model Microfast model M
 - b. Tyco model TY-FRB
 - c. Reliable
- D. Sidewall Sprinklers:
 - 1. Type: Horizontal recessed
 - 2. Finish: White factory finish
 - 3. Manufacturer:
 - a. Viking model Microfast model M
 - b. Tyco model TY-FRB
 - c. Reliable model G3

2.4 DRY PIPE VALVE

- A. General Requirements:
 - 1. Furnish and install dry pipe valve(s) as indicated on the plans.
 - 2. Standard: UL 260 and FM approved.
 - 3. Pressure Rating: 175 psig minimum.
 - 4. Body Material: Ductile Iron
 - 5. Body Type: Clapper
 - 6. Includes: all trim, including but not limited to: priming cup, fill valve, priming test valve, electric alarm switch, alarm test valve, air control valve, air relief valve, main drain valve, and pressure gauges
 - 7. Manufacturer:
 - a. Viking
 - b. Tyco
 - c. Reliable

2.5 PRE-ACTION SYSTEM

A. General Requirements:

1. Furnish and install a pre-action system as indicated on drawings. The pre-action system shall be provided with all necessary appurtenances to complete the system.
2. Standard: UL and FM approved.
3. Type: Single Interlock Release
4. See sections below for individual part specifications

2.6 PRE-ACTION VALVE

A. General Requirements:

1. Furnish and install deluge valve(s) as indicated on the plans.
2. Standard: UL 260 and FM approved.
3. Pressure Rating: 250 psig minimum.
4. Type: Straight-through pattern
5. Valve differential: 2:1 priming chamber to inlet chamber.
6. Inlet and Outlet Connections: flanged by flanged, flanged by grooved, or grooved by grooved.
7. Installation Orientation: vertical or horizontal.
8. Manufacturer:
 - a. Viking model F-1
 - b. Tyco model DV5A
 - c. Reliable

2.7 PRE-ACTION VALVE TRIM

A. General Requirements:

1. Furnish and install deluge valve(s) trim as required for complete system.
2. Standard: UL and FM approved and listed for use on a deluge system.
3. Pressure Rating: 250 psig minimum.
4. Material: Galvanized steel.
5. Manufacturer: Shall be same manufacturer as pre-action valve.

2.8 SOLENOID VALVE

A. General Requirements:

1. Furnish and install electrically operated solenoid valve as deluge valve priming water release device.
2. Standard: UL and listed for use on a deluge valve as specified above.
3. Pressure Rating: 250 psig minimum.
4. Body: 1/2 inch brass
5. Core Tube, Core, Plugnut and Springs: Stainless steel
6. Manufacturer: Shall be same manufacturer as pre-action valve.

2.9 SYSTEM CONTROL VALVE

A. General Requirements:

1. Standard: UL and FM approved for fire protection installations.
2. Pressure Rating: Normal system pressure but not less than 175 psig.
3. Type: Listed indicating type
4. Manufacturer: Shall be same manufacturer as pre-action valve.

2.10 CHECK VALVE

A. General Requirements:

1. Standard: UL and FM approved for use on fire protection systems.
2. Pressure Rating: 250 psig minimum.
3. Body: Ductile Iron
4. Seat: Brass
5. Clapper: Rubber faced assembly hinged w/o a removable access cover.
6. Removable access cover.
7. Manufacturer: Shall be same manufacturer as pre-action valve.
 - a. Viking model F-1 Easy Riser Check Valve
 - b. Tyco model CV-1F
 - c. Reliable

2.11 LOW PRESSURE ALARM SWITCH

A. General Requirements:

1. Enclosure Standard: UL and FM approved for application in which it is used.
2. Compatibility: Switch shall be compatible with system devices.
3. Wiring: Ability to be wired for Class A or Class B Service.
4. Switches: Two SPDT (single-pole double-throw) snap action
5. Manufacturer:
 - a. Viking part number 09472 or 09473
 - b. Approved equal.

2.12 ALARM PRESSURE SWITCH

A. General Requirements:

1. Enclosure Standard: UL and FM approved for application in which it is used.
2. Compatibility: Switch shall be compatible with system devices.
3. Wiring: Ability to be wired for Class A or Class B Service.
4. Manufacturer:
 - a. Viking part number 09470 or 09471
 - b. Approved equal.

2.13 AIR MAINTENANCE DEVICE

A. General Requirements:

1. Standard: UL and FM approved.

2. Bypass: 1/4 inch air supply with field adjustable air pressure regulator with built in ball check valve.
3. Accessories:
 - a. /Strainer
 - b. Pressure Regulator
 - c. Isolation Valves on each side.
4. Factory Pressure: 40 PSI
5. Manufacturer:
 - a. Tyco AMD
 - b. Viking Model D-2

2.14 AIR COMPRESSOR

- A. General Systems:
 1. Capacity: Appropriately sized for system volume
 2. Type: belt driven, single stage, air cooled with replaceable steel valves.
 3. Power:
 - a. Less then 3/4 HP shall be 120 volt
 - b. 3/4 HP and above shall be 3 phase of suitable voltage available in the building.
 4. Manufacturer:
 - a. Viking
 - b. Or approved equal.
- B. UL 2125 Approved Systems:
 1. Capacity: 150 gallons or less
 2. Compressor: Riser mounted, electric motor-driven, air-cooled, single-stage, oil-less
 3. Motor: 1/4 horsepower
 4. Production: 1.5 SCFM at 50 PSI
 5. Field Adjustable Pressure Range: 14 to 60 PSI.
 6. Accessories on Discharge Piping:
 - a. Pressure relieve valves with factory setting of 65 PSI.
 - b. 1/4 inch check valve
 7. Manufacturer:
 - a. Viking Model G-1
 - b. Or approved equal.
- C. Automatic Purge Vent/Valve:
 1. Vents oxygen during system nitrogen fill.
 2. Automatically closes when 98 percent minimum nitrogen has been reached.
 3. Sized to allow correct purge rate per manufacturer's written instructions and with 14 days.
 4. Provide one venting device for each dry/preaction sprinkler system zone.
 5. Include a connection port for a portable nitrogen purity sensor or a nitrogen purity manifold.
- D. Supervisory Gas Monitoring - Nitrogen Purity Sensing Device:
 1. Portable Handheld Nitrogen Purity Sensing Device: Portable sensing device to connect to the outlet of the automatic purge/vent valve during periodic inspections to obtain a nitrogen purity reading within each zone.

2. Permanently Mounted Nitrogen Purity Monitoring Device or Manifold: Permanent monitoring device to continuously monitor system's nitrogen purity.
- E. BAS Alarm Integration:
 1. Provide nitrogen generation system with integrated leak detection and bypass alarms. Program alarms into controller and connect to BAS.
 - a. Leak detection system is to alarm if leaks develop within fire suppression system piping.
 - b. Air bypass alarm is to alarm if nitrogen generation system is bypassed by air compressor.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- F. Install sprinkler piping with drains for complete system drainage.
- G. Connect compressed-air supply to dry-pipe sprinkler piping.
- H. Connect air compressor to the following piping and wiring:
 1. Pressure gauges and controls.
 2. Electrical power system.
 3. Fire-alarm devices, including low-pressure alarm.
- I. Install alarm devices in piping systems.
- J. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13.

- K. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gauges with connection not less than 1/4 inch and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.
- L. Drain dry-pipe sprinkler piping.
- M. Pressurize and check dry-pipe sprinkler system piping and air-pressure maintenance devices.

3.2 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. Install unions adjacent to each valve in pipes 2 inch and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having 2-1/2 inch and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. 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.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- I. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 INSTALLATION OF VALVES AND SPECIALTIES

- 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.
- D. Specialty Valves:
 - 1. Install valves in vertical position for proper direction of flow, in main supply to system.
 - 2. Install [dry-pipe] [and] [deluge] valves with trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
 - a. Install air compressor and compressed-air-supply piping.
 - b. Install air-pressure maintenance device with shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with [14- to 60-psig] <Insert value> adjustable range; and [175-psig] <Insert value> maximum inlet pressure.
 - c. Install compressed-air-supply piping from building's compressed-air piping system.

3.4 INSTALLATION, SPRINKLER HEADS

- A. Sprinklers located in locations where they are likely to be damaged shall be furnished with wire guards.
- B. Sprinklers located in Natatoriums, showers, wet areas, or subject to corrosion shall be furnished with a corrosion resistant wax coating over polyester coated sprinkler.
- C. Sprinklers located beneath open grating shall be furnished with shields.
- D. Temperature range and response time shall be suitable for the location and the expected heat release.
- E. Within a space all sprinklers should be the same Temperature Range and Response Time to avoid "skipping".
- F. Sprinklers shall be of types indicated in the contract documents.
- G. Sprinkler selection shall be such to facilitate complete system drainage if charged.
- H. Water sitting in sprinklers drops is not permissible.

3.5 INSTALLATION, DRY PIPE VALVE

- A. Furnish and install at the interface from the water supply to the dry pipe sprinkler system a dry pipe valve.
- B. Dry pipe valve shall be capable of maintaining the system prime while the system remains pressurized.
- C. Dry pipe valve shall be provided with contacts for monitoring both high and low air pressures.
- D. Dry pipe valve shall be installed in the vertical position with air/priming water above the valve and system water below the valve.
- E. Where required by system volume or system response time furnish and install an accelerator.
- F. All dry systems, regardless of volume, shall deliver sustained water flow to Inspector's Test Connection within 60 seconds.

3.6 INSTALLATION, PRE-ACTION SYSTEM

- A. The method of release of the deluge valve priming water pressure shall be released by an activation of the supplemental detection system only.
- B. The pre-action system riser shall be a listed and approved assembly.
- C. The system riser shall be equipped with a rubber seated check valve downstream of the deluge valve and prior to the supervisory air connection.
- D. The pre-action system shall be of the Single Interlock Release type.
- E. The building fire alarm system shall be configured to control the single interlocked pre-action fire protection system providing all functionality as required by UL, FM, and the local authority having jurisdiction.
- F. Supplemental detection devices shall be provided and installed as indicated in the contract documents.

3.7 INSTALLATION, PRE-ACTION VALVE

- A. The valve trim shall be compatible.
- B. The valve trim shall be installed following the manufacturer's specifications.

3.8 INSTALLATION, PRE-ACTION VALVE TRIM

- A. The deluge valve trim shall incorporate a prime shut-off valve (PSOV) of the same manufacturer as the deluge valve to provide a hydraulic means to positively close the supply of priming water to the priming chamber.

- B. The deluge valve trim shall be equipped with an emergency manual release enclosed in a steel box with appropriate labeling.
- C. The deluge valve trim shall be equipped with alarm connections for the electrical or mechanical activation of water flow alarms.

3.9 INSTALLATION, CHECK VALVE

- A. The sprinkler riser check valves shall be manufactured with supply side and system side gauge connections and a main drain outlet in conformance with NFPA 13, Standard for Installation of Sprinkler Systems.
- B. The check valves shall be equipped with a removable access cover for periodic inspection as required in NFPA 25, Standard for Inspection, Testing and Maintenance of Water-Based Fire Protection Systems.

3.10 INSTALLATION, LOW PRESSURE ALARM SWITCH

- A. A supervisory air pressure shall be maintained.
- B. A low air pressure alarm shall activate by way of a pressure supervisory alarm pressure switch.

3.11 INSTALLATION, ALARM PRESSURE SWITCH

- A. Water flow will activate an alarm by way of an alarm pressure switch.

3.12 INSTALLATION, AIR MAINTENANCE DEVICE

- A. Air supplies provided for sprinkler systems shall be equipped with an automatic air pressure maintenance device.
- B. A bypass shall be provided to eliminate air loss when system is in service.

3.13 INSTALLATION, AIR COMPRESSOR

- A. Furnish and install an appropriately sized air compressor for the system volume.
- B. Contractor shall confirm necessary approval requirements with owner.
- C. All electrical power requirements for the air compressor shall be the responsibility of this section of the specification (refer to Division 26 drawings for riser diagrams and panel schedules for locations of obtaining power).
- D. As soon as the Contractor knows what the power requirements are for the air compressor and where its installed location will be, the Contractor shall inform the Architect/Engineer in writing his intentions for obtaining power.

- E. From the air compressor connection to the dry pipe valve, furnish and install an air maintenance device consisting of a strainer and pressure regulator with isolation valves on each side, and a maintenance bypass with a service valve.
- F. Discharge piping shall include a check valve to prevent system air pressure loss.

3.14 CLEANING AND PROTECTION

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.15 PIPING SCHEDULE

- A. General Requirements:
 - 1. Comply with requirements of this section for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
 - 2. Manufacturers:
 - a. Anvil International, Inc.
 - b. Tyco Fire & Building Products
 - c. Victaulic Company
- B. The following types of fittings are prohibited: plain end couplings and fittings, saddle/mechanical/clamp branch tee, grooved flange rings, and grooved reducing couplings.
- C. Size: 2-1/2" and larger above grade.
 - 1. Pipe: Schedule 10 Steel, "listed" lightweight steel with a minimum UL Corrosion Resistance Ratio of 1.0, or Schedule 40 steel at the Contractor's option.
 - 2. Fittings: Butt-welded, groove-end, forged steel flanges, thread-o-let, weld-o-let.
 - 3. Joints: Butt welded, groove-end couplings, flanged.
- D. Size: 2" and smaller above grade.
 - 1. Pipe: Schedule 40.
 - 2. Fitting: Cast iron.
 - 3. Joints: Screwed, groove-end.

END OF SECTION 21 00 40

SECTION 21 00 70 – STANDPIPE AND HOSE SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cabinets
 - 2. 2-1/2 inch Hose Valves
 - 3. Hoses
 - 4. Nozzles
 - 5. Monitors
- B. Related Requirements:
 - 1. Section 21 00 00 FIRE PROTECTION SYSTEMS

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 CABINETS

- A. General Requirements:
 - 1. Furnish and install fire department valve cabinets as indicated on the plans and where required by Authority having jurisdiction.

2. Standard: UL and FM approved.
3. Door and Frame Material: 20 ga. Stainless Steel 304 with #4 finish
4. Door Style: Full Glass with Tempered Safety Glass
5. Type: Recessed.
6. Hinge: Continuous steel
7. Components: powder-coated with an electrostatically-applied thermally-fused, recoatable white polyester finish.

B. Valve Cabinet

1. Valve: 2-1/2 inch fire department valve and cap.
2. Manufacturer:
 - a. Potter Roemer model 1810 series

C. Fire Hose Cabinet

1. Fire Hose Rack Assembly: 1-1/2 inch size
2. Valve: 2-1/2 inch fire department valve and cap
3. Manufacturer:
 - a. Potter Roemer model 1200 series

2.3 2-1/2" HOSE VALVES

A. General Requirements:

1. Furnish and install at each valve cabinet and at locations on roof as indicated on the plans and where required by Authority having jurisdiction.
2. Standard: UL and FM approved.
3. Pressure Rating: 300 psi
4. Material: Cast Brass
5. Finish: Polished Brass
6. Size: 2-1/2 inch hose connection conforming with the local Fire Department requirements.
7. Cap: Provide cap with chain.
8. Manufacturer:
 - a. Potter-Roemer 4065

2.4 1-1/2" BY 2-1/2" HOSE RACK ASSEMBLY

A. General Requirements:

1. Furnish and install at each valve cabinet as indicated and where required by the Authority having jurisdiction.
2. Standard: UL and FM approved.
3. Hose Material: Lined 500 lb. Polyflex
4. Nozzle: Satin Brass Fog Nozzle
5. Hose Size: 1-1/2 inch
6. Hose Length: [50] [75] [100] feet
7. Valve: 2-1/2 inch angle
8. Rack Material: Red Polyester Coated Steel
9. Manufacturer:
 - a. Potter-Roemer 2700 Series

2.5 MONITORS

- A. General Requirements:
 - 1. Type: Stationary.
 - 2. Nozzle: UL 401, 2-1/2 inch, brass, adjustable from fog spray to straight stream to shutoff.
 - 3. Horizontal Rotation: 360 degrees with locking device.
 - 4. Vertical Rotation: 80-degree elevation and 60-degree depression with locking device.
 - 5. Waterway: [Double] [Single] brass or stainless-steel tube.
 - 6. Waterway Size: 2-1/2 inch minimum.
 - 7. Water Stream Flow: [500 gpm] [750 gpm] [1000 gpm].
 - 8. Operation: [Lever] [Wheel].
 - 9. Base Inlet Size: [2-1/2] [3] [4] inch.
 - 10. Finish: Red-painted body with brass trim.

PART 3 - EXECUTION

3.1 INSTALLATION, HOSE STATION

- A. Install 2-1/2 inch hose connections with quick-disconnect 2-1/2 by 1-1/2 inch reducer adapter and flow-restricting device unless otherwise indicated.
- B. Install wall-mounted, rack hose stations in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Section 104413 "Fire Protection Cabinets."

3.2 INSTALLATION, MONITORS

- A. Install monitors on standpipe piping.

3.3 PIPING SCHEDULE

- A. The standpipe wet or dry shall match the respective pipe schedule for wet or dry sprinkler system.

END OF SECTION 21 00 70

SECTION 22 00 00 – PLUMBING WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provisions and conditions cited in this Section shall apply to Work for other sections of Divisions 22 of these Specifications.
 - 1. Section 22 10 00 – Plumbing Piping Systems
 - 2. Section 22 40 00 – Plumbing Fixtures
 - 3. Section 22 50 00 – Plumbing Equipment
 - 4. Section 22 80 00 – Plumbing Specialties
- C. The following sections of the Specifications apply to Work under this Section
 - 1. Division 20 - Basic Mechanical Conditions and Basic Mechanical Material and Methods
 - 2. Division 25 - Temperature Control (for monitoring domestic water temperature)

1.2 SECTION INCLUDES

- A. Furnish material, labor and services necessary for and incidental to providing the following Plumbing Work where shown on the Plans and as hereinafter specified. Include all necessary work in the related sections of the Specifications (Subsection 20 00 43) to perform the Work completely.
 - 1. Sanitary waste system, including but not limited to, sanitary piping, vent piping, acid waste, acid vent piping, plumbing fixtures, floor drains, and cleanouts.
 - 2. Storm water drainage system, including but not limited to, storm water piping, roof drains, overflow drains, area drains, deck drains, subsoil drain, sump pump, and cleanouts.
 - 3. Potable domestic water system, including but not limited to, backflow preventers, pressure regulators, water meter, cold water piping, hot water piping, hot water return piping, and connection to all plumbing fixtures, equipment or specialties.
 - 4. Domestic hot water system, including but not limited to, gas fired/electric hot water heater, storage tank, circulator pump, and expansion tank. Refer to Division 23 for heat exchanger scope.
 - 5. Valved branches in the potable domestic water system with backflow preventers for extension under other sections of the specification for make-up water usage.
 - 6. Water softener system including, but not limited to mineral tank, brine tank, automatic controls, unsoftened and softened water piping.
 - 7. Pool drainage system, including but not limited to, continuous perimeter deck drain, individual deck drains, deck drain piping, and cleanouts.
 - 8. Contractor shall coordinate his work with the work of other trades, and with the architectural and structural drawings.
 - 9. Draining, filling, and venting of all modified systems as required for the above work. This includes scheduling shutdowns with the Owner. (Refer to Section 20 10 70).
 - 10. Provide sufficient labor and resources required for the testing and balancing (Refer to Section 20 10 80) and for the commissioning process (Refer to Section 152300).

11. Smoke stopping of all penetrations of pipes and firestopping of the same through fire rated partitions as shown on the architectural drawings including, but not limited to stairways, shafts, corridors, floors, roofs, and required exits. (Refer to Section 20 10 20).
12. Cleaning and pressure testing equipment, piping, and accessories installed under this section of the specification. (Refer to Section 20 10 50).
13. All seismic restraints for the above work. (Refer to Section 20 10 40).
14. Installing accessories specified under other sections of the specification referenced in subsection 20 00 05.

1.3 REFERENCES

- A. Applicable requirements of the current and accepted edition of the following industry standards, codes and specifications shall apply to the Work for Division 22
1. ANSI American National Standards Institute
 2. ASME American Society of Mechanical Engineers
 - 3.ASSE American Society of Sanitary Engineers
 4. CISPI Cast Iron Soil Pipe Institution
 5. NSF National Sanitation Foundation
 6. NIOSH National Institute of Occupational Safety and Health
 7. OSHA Occupational Safety and Health Act
 8. UL Underwriters Laboratory, Inc.

1.4 QUALITY ASSURANCE

- A. Work for this Section of the Specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Division 20.
- B. The plumbing system shall comply with the 2011 Reduction of Lead in Drinking Water Act. Components shall be "lead free" equivalent of model number specified regardless if manufacturer's prefix and suffix have been included.
- C. All operable devices and features of plumbing fixtures, accessories, equipment and specialties provided for in the Scope of Work of this Section shall be operated and proved to function satisfactorily for a period of eight (8) hours. Adjust, balance, lubricate as required, and instruct the Owner in the proper operation and maintenance of each device.
- D. Plumbing fixtures, equipment and specialties shall be protected against damage in the period between installation and acceptance. Any item damaged shall be removed, repaired and/or replaced at no additional compensation.
- E. Protect drains during entire construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- F. Place plugs in the ends of uncompleted piping at the end of each day or when work stops.

1.5 ACTION SUBMITTALS

- A. Contractor shall submit coordination drawings to the Engineer for review prior to any fabrication or installation. (Refer to Section 20 10 50).
- B. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

1.6 CLOSEOUT SUBMITTALS

- A. Refer to General Conditions and Division 20.
- B. As-built drawings of underground plumbing shall include dimensions from walls/columns and invert elevations.
- C. At the completion of the project, submit a letter stating all materials are asbestos free, and meet the specified ASTM E-84 flame/smoke rating of 25/50, and that all piping and duct penetrations are smoke or fire stopped as required by the Code.

1.7 EXISTING CONDITIONS

- A. Where lines installed under this section of the specification tie-in to existing lines Contractor shall verify all existing lines, their elevations and directions of flow before running any new lines.
- B. Contractor shall notify Architect/Engineer upon discovery if the new line cannot tie-in to the existing line due to location, elevation, size, or direction of flow.
- C. Prior to excavation, best efforts shall be made to locate lines with cameras, locating sondes, ground penetrating radar, etc.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 22 00 00

SECTION 22 10 00 – PLUMBING PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sanitary piping
2. Storm piping
3. Domestic water piping
4. Non-potable water piping
5. Subsoil drainage
6. Acid waste piping
7. Natural gas piping

B. Related Requirements:

1. Section 22 00 00 PLUMBING WORK

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Submit a schedule indicating: System, pressure class, pipe material, fittings, joint type, and pressure test.

1.3 INFORMATIONAL SUBMITTAL

- A. System purging and disinfecting activities report.
- B. Pressure test reports.
- C. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Installers are to be certified as having been trained and qualified to install and join piping. Installers of specialty systems shall have a current certification, not greater than one year prior, by pipe/joint manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Domestic water piping, tubing, fittings, joints, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent. Components shall be "lead free" equivalent of model number specified regardless if manufacturer's prefix and suffix have been included.
- B. Provide approved backflow preventers in all branch lines in the domestic water system for connections to non-domestic applications.
- C. See Division 20 for piping material specifications.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. PIPING MATERIAL SCHEDULE P-1
 - 1. Service:
 - a. Storm water drainage (ST), below grade.
 - b. Sanitary waste (SAN), and Vent (V), below grade.
 - c. Deck Drain (DD), below grade.
 - d. Piping within the building perimeter to 5' beyond the building limit.
 - 2. Design:
 - a. Pressure: gravity vented.
 - b. Temperature: 140 degrees F.
 - 3. Pipe: Service weight cast iron, bell and spigot.
 - 4. Fittings: Cast iron bell and spigot.
 - 5. Joints: Neoprene rubber compression type gasket.
- B. PIPING MATERIAL SCHEDULE P-2
 - 1. Service:
 - a. Storm water drainage (ST), below grade.
 - b. Sanitary waste (SAN), and Vent (V), below grade.
 - c. Deck Drain (DD), below grade.
 - d. Piping within the building perimeter to 5' beyond the building limit.
 - 2. Design:
 - a. Pressure: gravity vented.
 - b. Temperature: 140 degrees F.
 - 3. Pipe: Schedule 40 PVC solid core.
 - 4. Fittings: Schedule 40 PVC DWV.
 - 5. Joints: Solvent.

C. PIPING MATERIAL SCHEDULE P-3

1. Service:
 - a. Storm water drainage (ST), above grade.
 - b. Sanitary waste (SAN) and Vent (V), above grade.
 - c. Piping within the building perimeter.
2. Design:
 - a. Pressure: gravity vented.
 - b. Temperature: 140 degrees F.
3. Pipe: Cast iron soil pipe, no-hub.
4. Fittings: Cast iron, no-hub.
5. Joints: No-hub stainless steel coupling assembly, with neoprene rubber gasket.

D. PIPING MATERIAL SCHEDULE P-4

1. Service:
 - a. Storm water drainage (ST), above grade where concealed within pipe chases, or non-return air plenum.
 - b. Sanitary waste (SAN), and Vent (V), above grade where concealed within pipe chases, or non-return air plenum.
2. Design:
 - a. Pressure: gravity vented.
 - b. Temperature: 140 degrees F.
3. Pipe: Schedule 40 PVC solid core.
4. Fittings: Schedule 40 PVC DWV
5. Joints: Solvent.
6. Flashing: Provide 6 #/SF sheet lead flashing consistent with the type of roof construction x 12" high for all vents-thru-roof (VTR), except for membrane type roofing only which flashing shall be provided by roofing contractor. Minimum VTR shall be 3" size (see also 20 10 26).

E. PIPING MATERIAL SCHEDULE P-5

1. Service:
 - a. Domestic water, above grade. Includes cold water (CW), hot water (HW), hot water circulating (HWC) and softened water (SW).
 - b. Sump pump discharge piping.
2. Design:
 - a. Pressure: 100 psig.
 - b. Temperature: 180 degrees F. max. for hot water only.
3. Pipe: Copper, hard drawn, seamless, type L.
 - a. Fittings: Wrought copper, solder ends.
 - b. Dielectric Isolation union/union flanges between Fittings: water piping and non-copper connections and at all equipment connections.
4. Flanges: Cast bronze, 125 psi.
5. Joints: 95/5 Solder
6. Valves (refer to Section 20 00 13):
 - a. Shut-off/Service:
 - 1) 3" and smaller Ball valve, bronze body, two piece, full port, stainless steel ball and trim.
 - 2) 4" and larger Gate valve, Class 125 cast iron body, bolted bonnet, non-rising stem, resilient wedge.

- b. Balancing/Throttling:
 - 1) All sizes Multi-turn calibrated balance valve
 - 2) Recirculation (end of runs): Thermostatic recirculation balance valve (refer to Section 22 80 00)
- c. Check Valve:
 - 1) 3" and smaller Class 125 bronze, horizontal swing, Y-pattern, regrinding type, renewable seat and disc, solder ends.
 - 2) 4" and larger Class 125-iron body, bolted bonnet, horizontal swing, renewable seat and disc, bronze mounted, flanged ends.
- d. Hose End Valve: Interior: 3/4" hose thread outlet x copper sweat inlet with integral vacuum breaker. Nibco figure 63-VB.

F. PIPING MATERIAL SCHEDULE P-6

- 1. Service:
 - a. Domestic cold water (CW), above grade, 1/2" and smaller for connection from ice maker box/water supply box to ice maker, refrigerator, coffee machine, etc.
- 2. Design:
 - a. Pressure: 100 psig.
 - b. Temperature: 180 degrees F. max.
- 3. Pipe: Copper, annealed, seamless, type L.
 - a. Fittings: Rough brass, compression ends.
- 4. Valves (refer to Section 20 00 13):
 - a. Shut-off/Service:
 - 1) 1/2" and smaller angle or straight stop, depending on installation location.

G. PIPING MATERIAL SCHEDULE P-7

- 1. Service: Potable water, 2" and smaller, below grade – inside the building.
- 2. Design: Pressure: 100 psig. Temperature: 150 degrees F.
- 3. Pipe: Copper, annealed "soft", seamless, type K.
- 4. Fittings: Wrought copper, solder ends.
- 5. Joints: 95-5 solder.

H. PIPING MATERIAL SCHEDULE P-8

- 1. Service: Storm water drainage (ST), below grade. Piping 5' beyond the building limit.
- 2. Design: Pressure: gravity vented. Temperature: 140 degrees F.
- 3. Pipe: SDR-26 or heavier PVC.
- 4. Fittings: Schedule 40 PVC.
- 5. Joints: Neoprene rubber compression type gasket, push joint.

I. PIPING MATERIAL SCHEDULE P-9

- 1. Service: Sanitary waste (SAN), below grade. Piping 5' beyond the building limit.
- 2. Design:
 - a. Pressure: gravity vented.
 - b. Temperature: 140 degrees F.
- 3. Pipe: SDR-26 or heavier PVC.
- 4. Fittings: Schedule 40 PVC.
- 5. Joints: Neoprene rubber compression type gasket, push joint.

J. PIPING MATERIAL SCHEDULE P-10

1. Service: Potable water, below grade – outside the building.
2. Rating: Pressure: 250 psig at 150°F
3. Pipe:
 - a. 3” and larger: Ductile iron pressure pipe, bituminous-coated Exterior, Cement lined interior.
 - b. 2” and smaller: Copper, annealed “soft”, seamless, type K.
 - c. 2” – 4” : Copper, drawn “hard”, type K.
4. Fitting:
 - a. Ductile iron, mechanical joint, bituminous coated exterior. Cement lined interior.
 - b. Wrought copper, solder ends.
5. Joints:
 - a. Ductile Iron: EBAA Iron Megalug or equivalent restraints at all joints.
 - b. Copper: 95-5 solder
6. Valves: Gate valve, Class 125 cast iron body, bolted bonnet, non-rising stem, resilient wedge, stem nut, and curb box.

K. PIPING MATERIAL SCHEDULE P-11

1. Service: Subsoil drainage, 3” and larger below grade.
2. Design:
 - a. Pressure: gravity vented.
 - b. Temperature: 80°F
3. Pipe: Schedule 40 PVC perforated subsoil pipe.
4. Fittings: Schedule 40 PVC DWV.
5. Joints: Solvent.

L. PIPING MATERIAL SCHEDULE P-12

1. Service: Subsoil drainage, 3” and larger below grade.
2. Design:
 - a. Pressure: gravity vented.
 - b. Temperature: 80°F
3. Pipe: HDPE ASTM F405 Corrigated, Single Wall, Slot perforated subsoil pipe with geotextile wrap.
4. Fittings: HDPE.
5. Joints: Mechanical Fit

M. PIPING MATERIAL SCHEDULE P-13

1. Sanitary drain hose from ice maker, drink dispenser, etc.
2. Pressure: gravity vented.
3. Temperature: 140 degrees F.
4. Pipe: Clear PVC with polyester reinforcing braid.
 - a. Meets requirements of FDA 3A 20-27.

3.2 INSTALLATION OF PIPING

- A. The Plans indicate the approximate location and arrangement of roughing-in for waste, vent and domestic water piping to serve the respective plumbing fixture, equipment and specialties. Final locations and arrangements shall be determined from approved shop drawings of the respective item.

- B. Install copper tubing in accordance with CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping in accordance with AWWA C600 and AWWA M41. Note #1: Provide retainer glands where flanged ductile iron pipe is installed at point of building entry.
- D. Install cast-iron piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- E. Install aboveground PVC piping in accordance with ASTM D2665.
- F. Install belowground PVC piping in accordance with ASTM D2321.
- G. Pressure test each respective piping system for tightness to the test pressure indicated without loss. Repair any leaks and retest, as required. If test pressure is not indicated, hydrostatically test to 1.5 times the system operating pressure.
 - 1. Storm water drainage, sanitary waste and vent, deck drain piping: Pressure test at not less than 15 feet static head of water for two (2) hours minimum.
 - 2. Domestic water inside the building: Hydrostatically pressure test at 150 psi for four (4) hours minimum.
 - 3. Ductile iron domestic water piping outside the building: Hydrostatically pressure test at 200 psi for four (4) hours minimum.
 - 4. CSST gas piping (appliance connector or vented sleeve lab gas): New piping shall be installed, capped, and pressure tested with Nitrogen at 50 psi for two (2) hours. After the piping has passed the above pressure test the final tie-ins shall be made, then the system will be filled with natural gas and the final joints will be checked with soap.
- H. Main vents shall be the same size as waste lines and shall extend 12" minimum above the roof. Minimum vent thru the roof (VTR) shall be 3" size.
- I. Install all piping with pitch to vent or drain. Provide drain valves at low points and air vents at high points. Drain valves and air vents shall be 3/4" bronze, 2 piece body ball valves with 3/4" hose end adapter, cap, and chain. In 1/2" through 2" pipe, contractor may use Webstone model T-drain.
- J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- M. Install piping to permit valve servicing.
- N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- O. Install piping free of sags and bends.

- P. Install fittings for changes in direction and branch connections.
- Q. Install unions/flange/coupling at final connection to each piece of equipment to allow disconnection of equipment, except where coupling is integral to the equipment (i.e. supply lines to faucets, flush valves, etc.)
- R. Install sleeves for piping penetrations of walls, ceilings, and floors.
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors.
- T. Subsoil drainage: The trenches for the drain tile shall be excavated to allow at least 6" of filler material to be placed in the trench before laying the pipe and a backfill of at least 8" of filter material on both sides. Fill over the pipe shall extend to 18" above the pipe where located around the exterior of the building.
 - 1. The filler material shall be washed, uniformly graded mixture of crushed stone, or uncrushed gravel, with 100% passing 1" sieve, 90 to 100% passing 3/4" sieve, 15 to 40% passing 5/8" sieve, and 0 to 5% passing No. 4 sieve.
 - 2. A filler fabric shall be placed in the trench between the earth and filter material and shall completely enclose the filler material. The fabric shall be equal to Mirafi 140N; .5 oz. nonwoven fabric composed of strong rotproof polymeric fibers. The fabric shall be non-biodegradable and resistant to acids and alkali solutions within the pH range of 3 to 12. The fabric shall have the following physical properties.
 - a. E.O.S. #80 U.S. Standard Sieve
 - b. Water Permeability Coefficient (k): 0.07 cm/sec
 - c. Water Flow Rate: 48 ga./min/ft²
 - d. Thickness: 30 mils
 - e. Burst Strength: 125 psi
- U. Provide flexible copper water line of sufficient length to allow servicing and moving of appliance for cleaning without kinking piping.
- V. Provide ice maker drain hose of sufficient length to drain into floor sink or floor drain.

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. 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 pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
- D. Apply appropriate tape or thread compound to external pipe threads.
- E. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

- F. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
- G. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings in accordance with ASTM B828 or CDA's "Copper Tube Handbook."
- H. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- I. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on joint fittings by inserting tube to measured depth.
- J. Extruded-Tee Connections: Form tee in copper tube in accordance with ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- K. Joint Construction for Grooved-End Copper Tubing: Make joints in accordance with AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts per manufacturer's instructions.
- L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts in accordance with ASME B31.9.
- M. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- N. Hubless, Cast-Iron Soil Piping Coupled Joints:
 - 1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- O. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.
- P. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:
- Q. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
- R. CPVC Piping: Join in accordance with ASTM D2846/D2846M.
- S. PVC Piping: Join in accordance with ASTM D2855.

3.4 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 3 and Smaller: Use dielectric waterway plastic lined nipple.
- C. Dielectric Fittings for NPS 4 and Larger: Use dielectric flange kits.

3.5 ADJUSTING

- A. Perform the following adjustments before operation:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.6 FIELD QUALITY CONTROL

- A. Pipe cleaning:
 - 1. All domestic water lines shall be flushed clean at the completion of the Work. Refer to Section 20 10 56 – Cleaning of Piping Systems.
 - 2. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals.
 - 3. All drainage lines shall be flushed clean at the completion of the Work. Rod out any obstructions encountered.
- B. Pressure testing:
 - 1.

END OF SECTION 22 10 00

SECTION 22 30 00 – DRAINS AND CLEANOUTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Areaway Drains
2. Backwater Valves
3. Cast Iron Downspout Boots
4. Cleanouts
5. Deck Drains
6. Floor Drains
7. Floor Drain Trap Seal
8. Floor Sinks
9. Roof Drains
10. Shower Drains
11. Trench Drains

B. Related Requirements:

1. Section 22 00 00 PLUMBING WORK

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Submit a room-by-room schedule indicating floor drains and cleanouts to be used including top size, shape, floor finish material, and setting height with respect to concrete slabs.

1.3 QUALITY ASSURANCE

- A. Pre-installation meeting shall review the Contractors measures to ensure elevation of drains with respect to finished floors and squareness of square drains with respect finished walls and flooring.
- B. Pre-installation meeting shall review the installation of the roof drain, roof insulation and roofing waterproofing.

PART 2 - PRODUCTS

2.1 AREAWAY DRAINS

- A. (AD-A) Areaway Drain: Cast iron, double drainage flange spigot outlet, adjustable strainer heads, weep holes. Provide 5" Dome satin nickel bronze adjustable strainer with vandalproof screws for

finished tile floor application. Wade W1100K-1-VP, Zurn ZN-415G-VP, J.R. Smith 2005-G05-NB-U, MIFAB F1100-K-1-6, or Josam 30003-5D-VP.

2.2 BACKWATER VALVES

- A. Backwater valves installed in piping shall be cast iron body. ANSI B16.1 class 125 lb. flanged ends, with fabricated elastomer “duckbill” check sleeve. Flanged backwater valves shall be Red Valve Co., Series 39.
- B. Backwater valves installed at the point of discharge in sewer manholes shall be slip-on fabricated elastomer “duckbill” check sleeve. Backwater valve shall slip over pipe outside diameter and clamp on the pipe with stainless steel clamps. Slip-on backwater valves shall be Red Valve Co., Series TF-2.

2.3 CAST IRON DOWNSPOUT BOOTS

- A. Furnish and install one-piece cast iron downspout boots with integral brass cleanout and 5/8” fastening lugs. Downspout sizes and outlet sizes shall be coordinated with the plans. The length shall provide between 12” and 18” of exposed shoe above grade. Vertical storm piping may be required to obtain desired invert elevation. Downspout shoes shall be offset type as manufactured by Neenah, BarryCraft, J.R. Hoe, MIFAB, Wade, Zurn, or approved equivalent.

2.4 CLEANOUTS

- A. (FCO) interior finished floor:
 - 1. Cast iron body, threaded adjustable housing, flanged ferrule with straight tread gasketed bronze plug.
 - 2. Square secured satin nickel bronze scoriated top.
 - 3. Vandal proof fasteners
 - 4. Tops shall be for tile, carpet, ceramic tile, terrazzo tile as required.
 - 5. Wade W-8000-S-75-VP, Zurn ZN-1400-T-BP-VP, J.R. Smith 4041-U, MIFAB C1100-S-1-6, Sioux Chief 834-4DNQV, or Josam 55000-1-SQ-22-VP.
- B. (FCO) interior unfinished floor:
 - 1. Cast iron body, threaded adjustable housing, flanged ferrule with straight tread gasketed plug.
 - 2. Round secured satin nickel bronze scoriated top.
 - 3. Vandal proof fasteners.
 - 4. Wade W-8000-1-75-VP, Zurn Z-1400-BP-VP, J.R. Smith 4021-U, MIFAB C1100-R-1-6, Sioux Chief 834-4DNRV, or Josam 55000-1-22-VP.
- C. (WCO) wall type for concealed riser in finished spaces:
 - 1. Provide cleanout fitting with screwed plug opening and countersunk bronze plug.
 - 2. Provide 8” x 8” square access covers with polished nickel bronze beveled edge frame with anchor lugs for over the wall installation.
 - a. Smooth stainless steel cover.
 - b. Vandal proof fasteners.

3. Wade 8303-85-75-VP, Zurn ZANB-1460-9-VP, J.R. Smith 4730-U-NB, MIFAB C1460-S-3-6, or approved equivalent.
- D. (WCO) wall type for concealed riser in unfinished spaces:
1. Provide cleanout fitting with screwed plug opening and countersunk bronze plug.
 2. Provide round access covers.
 - a. Smooth stainless steel cover.
 - b. Vandal proof center screw.
 3. Wade, Zurn, J.R. Smith, MIFAB, Sioux Chief, Josam, or approved equivalent.
- E. (YCO) exterior location:
1. Cast iron body, threaded adjustable housing, flanged ferrule with straight tread gasketed plug.
 2. Round secured cast iron or ductile iron top.
 3. Wade W-8000-12-75-BP, Zurn Z-1400-BP-VP, J.R. Smith 4221-U, MIFAB C1100-XR-4-6, Sioux Chief 834-4DiRV, or Josam 55000-22-VP.

2.5 FLOOR DRAINS

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency. Where trap primers are indicated on the drawings, the appropriate option shall be provided on the respective drain.
- B. Floor Drain: interior finished floor (FD-A):
1. Cast iron body with flashing flange and seepage openings.
 2. 6" x 6" square adjustable satin nickel bronze strainer top.
 3. Vandal proof fasteners.
 4. 3" outlet.
 5. Wade W-1103-G6-1-VP, Zurn ZN-415-6S-VP, J.R. Smith 2005-B06NB-U, MIFAB F1100-S6-1-6, Sioux Chief 832-235NQV, or Josam 30000-6S-VP.
- C. Floor Drain: mechanical equipment room (FD-B):
1. Cast iron body with flashing flange and seepage openings.
 2. 7" cast iron loose set tractor strainer.
 3. 3" outlet.
 4. Wade W-1103-TS7-12, Zurn Z-415-7N, J.R. Smith 2000-D-CI, MIFAB F1100C-7N, Sioux Chief 833-23DiR, or Josam 30000 7E-93.
- D. Floor Drain: mechanical equipment room (extended rim) (FD-C):
1. Cast iron body with flashing flange and seepage openings.
 2. 7" satin nickel bronze extended rim strainer.
 3. 3" outlet.
 4. Wade W-1100-ER7-1, Zurn Z-415I, J.R. Smith 2005-F37NB, MIFAB F1100 ER7-1, Sioux Chief 833-23DNRE or Josam 30000 7E1.
 5. Install with rim flush to floor.
- E. Floor Drain: interior unfinished floor (FD-D):
1. Cast iron body with flashing flange and seepage openings.

2. 6" round adjustable satin bronze round strainer top, with vandal proof fasteners and 3" outlet. Wade W-1100-A6-VP, Zurn ZN-415-6B-VP, J.R. Smith 2000-A06NB-U, MIFAB F1340-Y-Q-1-6, Sioux Chief 833-235DNRV or Josam 30000-6A-VP.
- F. Floor Drain: heavy duty (FD-E):
1. Cast iron body with flashing flange and seepage openings.
 2. 12" adjustable satin nickel bronze, or ductile iron with satin nickel bronze veneer, round, heavy duty deep flange top.
 3. Vandal proof fasteners.
 4. 3" outlet.
 5. Wade W-1100-A6-VP, Zurn Z-505-T-VP, J.R. Smith 2141-NB-U, or Josam 32200-SD-VP.
- G. Floor Drain: interior finished floor acid resistant (FD-F):
1. Acid resistant epoxy coated cast iron body with flashing flange and seepage openings.
 2. 6" x 6" square adjustable satin nickel bronze strainer top.
 3. Vandal proof fasteners.
 4. 3" outlet.
 5. Zurn ZN-415-6S-VP, MIFAB F1100-S6-1-6-11, or approved equivalent by Wade, J.R. Smith, Sioux Chief or Josam.
- H. Floor Drain: round with funnel drain (FD-G):
1. Cast iron body with flashing flange, integral reversible clamping collar, and seepage openings.
 2. Adjustable nickel bronze, 6" round strainer top with 4" diameter funnel.
 3. 3" outlet.
 4. Wade 1100-A6-EF4, Zurn ZN-415E-T, J.R. Smith 2005-06-NB-X, MIFAB F1100-EF-1-6 or Josam 3000-7E2.
- I. Floor Drain: square with funnel drain (FD-H):
1. Cast iron body with flashing flange, integral reversible clamping collar and seepage openings.
 2. Adjustable nickel bronze, 6" square strainer top with 4" diameter funnel.
 3. 3" outlet.
 4. Wade 1100-G6-1-EF4, J.R. Smith 3510-06-NB, Josam 3000-S-F4, or equivalent by Zurn or MIFAB.
- J. Floor Drain: Large Bucket w/ integral cleanout (FD-K):
1. Fabricated steel body, epoxy coated with integral cleanout.
 2. Heavy duty cast iron grate.
 3. Sediment bucket.
 4. Bronze cleanout plug.
 5. 3" outlet.
 6. Zurn Z761, Wade 2080, JR Smith 2650, or Josam 38620-40.
- K. Floor Drain: pool backwash pit (FD-P):
1. Cast iron body with flanged integral clamping collar and seepage openings.
 2. Loose cast iron round grate.
 3. 3"outlet.
 4. Zurn Z503-C, Wade 1400-12, J.R. Smith 2141, MIFAB 1360-4, or Josam 32300.

- L. Floor Drain: mechanical equipment room (FD-S):
 - 1. Type CF8M or Type 316 Stainless steel body with flashing flange and seepage openings.
 - 2. 6" stainless steel satin finish top.
 - 3. 3" outlet.
 - 4. Wade W-1100SS-A6-85-316, Zurn ZM-1726-K, J.R. Smith 9700-CF8M, MIFAB F1100C-7N, Sioux Chief 833-23DiR, or Josam 30000-6A-SS-T-316.

2.6 FLOOR DRAIN TRAP SEAL

- A. Smooth, soft, flexible, elastomeric PVC material, open on top with closure at bottom. Allows wastewater to open and adequately discharge floor drain through its
- B. Interior. Closes and returns to original molded shape after wastewater discharge is
- C. Complete. Complies with ASSE 1072. Precision Plumbing Products Pro-Drain Trap Seal, ProSet Trap Guard, Rectorseal SureSeal, MIFAB MI-GUARD or approved equivalent.

2.7 FLOOR SINKS

- A. Floor Sink (FS-A):
 - 1. Cast iron 12" square floor sink with 8" sump.
 - 2. A.R.E. interior aluminum dome strainer.
 - 3. Nickel bronze hinged top.
 - 4. Wade W-9140, Zurn ZN-1901-K, J.R. Smith 3150, MIFAB FS1730-1, or Josam 49340A-LF-NB.
 - 5. Provide 16 gauge galvanized steel protective cover, painted safety orange, with protection to not scratch sink enamel for protection of sink during construction.
- B. Floor Sink (FS-B):
 - 1. Same as floor sink FS-A, except with sediment bucket.
 - 2. Wade W-9140-27, Zurn ZN-1901-K-23, J.R. Smith 3151, MIFAB FS1730-1-5, or Josam 49340A-LF-NB-33.
- C. Floor Sink (FS-C):
 - 1. 14 gauge Type 304 Stainless steel 12" square floor sink with 10" sump.
 - 2. Perforated outlet strainer.
 - 3. Top formed of 10 gauge bars on 1-1/2" centers.
 - 4. 8 gauge side banding bars, continuously welded.
 - 5. Kusel FS4-044-121210-O-S or approved equivalent.

2.8 ROOF DRAINS

- A. Roof Drain: (RD):
 - 1. Cast iron body with flange, flashing collar and gravel stop.
 - 2. Removable cast iron dome
 - 3. Under deck clamp.
 - 4. Sump receiver pan.
 - 5. Adjustable extension. Provide extension, as required, to suit thickness of roof construction.

6. Wade W-3000-AE-42-52-53, J.R. Smith 1015-R-C-CID, MIFAB R1200-EU-B-M-U, Josam 21500-AE-1-2-22, or high performance roof drain with funnel-shaped body: Zurn Z-100-C-EA-R.

B. Overflow Drain: (OV):

1. Cast iron body with flange, flashing collar and gravel stop.
2. Removable cast iron dome
3. Under deck clamp.
4. Sump receiver pan.
5. Adjustable extension. Provide extension, as required, to suit thickness of roof construction.
6. 2" high dam.
7. Wade W-3000-AE-D-42-52-53, Zurn ZC-100-C-EA-R-89. J.R. Smith 1045-R-C-CID, MIFAB R1200-EU-B-M-U-W2, or Josam 21500-16-AE-3-22.

C. Overflow Drain Nozzle (OFN):

1. Overflow drain downspout nozzle to be located at each discharge location.
2. Downspout cover shall be piece nickel bronze nozzle and flange with removable stainless steel bird screen.
3. No hub.
4. Josam 25010-BS-Z, Jay R. Smith 1770Y-NB-BS, MIFAB R1940-83, Wade 3940-NH-166, Watts RD-940-NH-83, or Zurn ZANB199-NH-SS.

2.9 TRENCH DRAIN

A. Trench Drain: (TD-A):

1. Cast iron floor drain with flange, integral clamping collar and seepage openings.
2. ½" plugged primer tap.
3. Adjustable 4" x 12" rectangular nickel bronze strainer
4. Vandal proof fasteners.
5. Wade W-1100-H4x12-1-VP, Zurn ZN-415-13J-VP, J.R. Smith 2000-MNB-U, MIFAB F1100-RS-1-6, or Josam 30000-R-VP.

B. Trench Drain: (TD-B):

1. Cast iron floor drain with flange, integral clamping collar and seepage openings.
2. ½" plugged primer tap.
3. Adjustable 4" x 12" rectangular nickel bronze strainer
4. Vandal proof fasteners.
5. Removable sediment bucket.
6. Wade W-1100-H4x12-1-VP-27, Zurn ZN-415-13J-Y-VP, J.R. Smith 2000-MNB-U-B, MIFAB F1100-RS-1-5-6, or Josam 30000-R-80-VP.

C. Trench Drain – Continuous Channel: (TD-C):

1. 6" [8"] [12"] [16"] wide, modular 16 gauge stainless steel drainage system.
2. Class C duty stainless steel slotted grate.
3. Manufacturer's standard device for securing grates to channel section. Zurn Z890, JR Smith 9660, or approved equivalent

D. Trench Drain – Continuous Channel: (TD-D):

1. 6" wide, modular polymer concrete channel drainage system.

2. [Ductile iron edge rail], [heavy] [medium] duty [ductile iron] [fiberglass] [stainless steel] grate with [slots] [perforations].
 3. Manufacturer's standard device for securing grates to channel section. JR Smith 9877, Polydrain PDX or approved equivalent.
- E. Trench Drain – Continuous Channel: (TD-E):
1. 6 inch wide presloped drainage system with 100 percent polypropylene interlocking channels.
 2. Radiused bottom.
 3. Ductile iron frame with concrete frame anchors
 4. Extra heavy duty, Load Class E ductile iron grate.
 5. Manufacturer's standard device for securing grates to channel section.
 6. JR Smith 9931, or approved equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Drain and cleanout outlets shall be compatible with respective piping material and size. Outlets below grade shall be push type. Outlets above grade may be no-hub or push type at the Contractor's option. Tops shall be compatible with the flooring system.
- B. Square/rectangular drains/cleanout tops shall be set square to the finished room walls. Tops that out of square by greater than 1/8" or produce an irregular floor title shall be corrected. Contractor's options to install with round block-outs during the concrete floor pour to allow subsequent adjustment.
- C. Provide full size cleanouts up to 4" size above the lowest floor line in all drainage risers, and where total of the fittings exceed 120 degrees and at changes in direction greater than 45 degrees in horizontal drainage lines, and at intervals of not greater than fifty (50) feet in straight piping runs 4" diameter and smaller, and one hundred (100) feet for piping over 4" diameter.
- D. Do not install cleanouts in electrical equipment rooms. Extend the cleanout to outside the room limits.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Where cleanout or drain is located in open ground, extend the cleanout to finished grade elevation and install a 16" x 16" x 8" deep concrete pad at grade to secure the cleanout.
- G. Provide deep seal P-traps for all floor drains.
- H. Any drain body set prior to approval shall be performed with block-outs to allow correct tops and finished heights to be adjusted.
- I. Install floor drains, floor sinks and shower drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 1. Set with grates depressed according to the following drainage area radii:

- a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
- J. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.
- K. Install roof drains in accordance with roof membrane manufacturer's written installation instructions at low points of roof areas.
 - 1. Install flashing collar or flange of roof drain to maintain integrity of waterproof membranes where penetrated.
 - 2. Install expansion joints, if indicated, in roof drain outlets.
 - 3. Position roof drains for easy access and maintenance.
- L. Install downspout boots at grade with top [18 inches] above grade. Secure to building wall.
- M. Install downspout nozzles at exposed bottom of conductors where they spill onto grade.
- N. Install horizontal backwater valves in floor with cover flush with floor.

3.2 PROTECTION

- A. Protect drains during construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.3 CLEANING

- A. Drain and cleanout tops shall be clean in as new condition free of concrete, grout, floor glue, tape, or tape residue.

END OF SECTION 22 30 00

SECTION 22 40 00 – PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water closets
2. Water closet seats
3. Water closet flush valves
4. Water closet carriers
5. Urinals
6. Urinal flush valves
7. Urinal carriers
8. Lavatories
9. Lavatory faucets
10. Lavatory accessories
11. Sinks
12. Sink Accessories
13. Sink faucets
14. Service Sinks
15. Laundry Tub
16. Mop Sink Basin
17. Drinking fountains
18. Electric water coolers
19. Emergency eye/face wash

B. Related Requirements:

1. Section 22 00 00 PLUMBING WORK

C. Furnish and install the following plumbing fixtures where shown on the Plans and as hereinafter specified. Plumbing fixtures shall be institutional/commercial grade fixtures, no residential or "trade" grade fixtures are acceptable. Plumbing fixtures and accessories shall have all options, body material, water consumption, and accessories as specified where or not listed as a prefix, suffix, or catalog number. Include all necessary work in the related sections of the Specifications (subsection 22 00 03) and accessories to provide for complete installation and operation of the respective fixture.

D. All plumbing fixtures and non-metal accessories shall be white color, except where shown or specified otherwise.

E. Vitreous china fixtures, where specified, shall be best quality, non-absorbent. Warped or imperfect fixtures shall not be accepted. Enameled cast iron fixtures, where specified, shall be thoroughly fused and bonded to body without discoloration, chips, flaws or cracks. Finish all exposed surfaces.

- F. Fixture trim shall be cast brass with polished chrome-plated finish on exposed surfaces, except where shown or specified otherwise.
- G. Fixture traps shall be tubular wall type, minimum 17 gauge with integral cleanout plugs, polished chrome plated finish, except where shown or specified otherwise. Size to suit fixture tailpiece. Comply with local plumbing code.
- H. All water closets, and urinals shall be from the same manufacturer. All faucets for lavatories, janitor sinks, and sinks shall be from the same manufacturer. All supplies and stops for lavatories and sinks shall be from the same manufacturer. All fixture carrier shall be from the same manufacturer.
- I. Furnish accessories for fixtures requiring trim, carriers, brackets, back-up plates, specialties, etc. for respective complete installation.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. ASME A112.19.2/CSA B45.1 - Ceramic Plumbing Fixtures
- C. ASME A112.19.5-2022/CSA B45.15:22 Flush valves and spuds for water closets, urinals, and tanks
- D. ASME A112.19.3-2022/CSA B45.4:22 Stainless steel plumbing fixtures

2.2 MANUFACTURERS

- A. Vitreous China Fixtures: American Standard, Kohler, Mansfield, Zurn, Sloan, Toto
- B. Stainless Steel Sinks: Elkay, Acorn, Advance Tabco, Ameteko Wasserstrom, Franke, Just.
- C. Carriers: Josam, J.R. Smith, MIFAB, Wade, Watts, Zurn
- D. Flush Valve: Sloan, AMTC, American Standard, Zurn
- E. Supplies, Strainer, Traps: McGuire, Chicago Faucets, Dearborn, Brass Craft, Engineered Brass, American Standard, Kohler, Elkay.
- F. Faucets: Chicago Faucets, T&S Brass], Elkay, Delta, Moen Commercial, Sloan, Zurn

2.3 WATER CLOSETS

- A. Wall hung:
 - 1. Vitreous china elongated bowl, 1.28-1.6 gal/flush.
 - 2. Siphon-jet.
 - 3. wall-mounted with 1-1/2" (top) inlet spud.
 - 4. High Efficiency Toilet (HET).
 - 5. Conforms to ASME Standard A112.19.2 fixture dimensions.
 - 6. American Standard "AFWALL Millennium FloWise" model 2257.101, Kohler "Kingston" model K-84325-0, Mansfield "Erie" model 1301, Sloan model ST-2459, Toto CT708E, or Zurn model Z5615-BWL. Mount at ADA height where scheduled on drawings.
- B. Floor mounted:
 - 1. Vitreous china elongated bowl, 1.28-1.6 gal/flush.
 - 2. Siphon-jet.
 - 3. Floor mounted 15" rim height, with 1-1/2" top inlet spud.
 - 4. High Efficiency Toilet (HET).
 - 5. Conforms to ASME Standard A112.19.2 fixture dimensions.
 - 6. American Standard "Madera FloWise" model 3451.001, Kohler "Wellcomme Ultra" model K-96053-0, Mansfield "Baltic" model 1311NS, Sloan model ST-2009, Toto CT705EN or Zurn model Z56545-BWL1.
- C. Floor mounted (ADA):
 - 1. Vitreous china elongated bowl, 1.28-1.6 gal/flush.
 - 2. Siphon-jet, floor mounted 17" rim height, with 1-1/2" top inlet spud.
 - 3. High Efficiency Toilet (HET).
 - 4. Conforms to ASME Standard A112.19.2 fixture dimensions, ADA, and ICC 117-1.
 - 5. American Standard "Madera FloWise" model 3043.001, Kohler "Highcliff" model K-96057-0, Mansfield "Adriatic" model 1319, Sloan model ST-2029, Toto CT705ELN or Zurn model Z5665-BWL.

2.4 WATER CLOSET SEATS

- A. Provide seats for each water closet furnished.
- B. Standard Seat:
 - 1. Heavy duty commercial, solid plastic, open front less cover for elongated bowl.
 - 2. Integral bumpers.
 - 3. Self-sustain hinges and external check hinges with stainless steel hinge pins and mounting bolts.
 - 4. American Standard model 5901.100SS, Bemis model 1955SSCT, Church model 295SSCT, or Zurn model Z5955SS-EL-ST5.

2.5 WATER CLOSET: FLUSH VALVES

- A. Provide flush valves for each water closet furnished, as scheduled.
- B. Manual 1.6 GPF:
 - 1. Diaphragm type, 1.6 gallons per flush manual closet flushometer.
 - 2. Metal oscillating non-hold-open handle.
 - 3. 1" IPS screw driver angle stop with protective cap.
 - 4. Adjustable tail piece.
 - 5. Vacuum breaker flush connection and spud coupling for 1-1/2" top spud, wall and spud flanges.
 - 1. Sloan model Royal 111-1.6, AMTC MF-700-T16, American Standard 6147161.002, or Zurn model Z6000AV-WS1
 - 2. Sloan model Royal model 111-1.6, no substitutions.
- C. Automatic, Battery Powered, 1.6 GPF:
 - 1. Diaphragm type, 1.6 gallons per flush closet flushometer.
 - 2. ADA compliant, battery powered automatic "no hands" operation.
 - 3. Chrome plated infrared sensor housing, angled sensor window.
 - 4. Manual override flush button.
 - 5. 1" I.P.S. screwdriver angle stop with vandal resistant stop cap.
 - 6. Adjustable tailpiece.
 - 7. Vacuum breaker flush connection, spud coupling and spud flange for 1½" top spud.
 - 8. Valve shall be in compliance with the applicable sections of ANSI/ASME A112.19.2.
 - 9. Valve to be actuated by 6VDC solenoid.
 - 10. Sloan model G2 Optima Plus G2 8111, AMTC AEF-802-CT-16 (top mounted) (Competitive)
 - 11. Sloan model Royal 111 SMO-1.6, AMTC model HSM-801-CT-16, or Zurn model ZR6000AV-WS1 (side mounted). (Competitive)
 - 12. Sloan G2 Optima Plus 8111, no substitutions. Flat Spec
- D. Automatic, Battery Powered, 1.28 GPF:
 - 1. Diaphragm type, 1.28 gallons per flush closet flushometer.
 - 2. ADA compliant, battery powered automatic "no hands" operation.
 - 3. Chrome plated infrared sensor housing, angled sensor window.
 - 4. Manual override flush button.
 - 5. 1" I.P.S. screwdriver angle stop with vandal resistant stop cap.

6. Adjustable tailpiece.
7. Vacuum breaker flush connection, spud coupling and spud flange for 1½" top spud.
8. Valve shall be in compliance with the applicable sections of ANSI/ASME A112.19.2. Sloan model Optima SMO 111-SMO-1.28, AMTC AEF-801-CT-12, American Standard 6147SM121.002, or Zurn model ZER6000PL-HET-CPM.
9. Sloan model G2 Optima Plus 8111-1.28, no substitutions.

2.6 WATER CLOSET: CARRIERS

A. Carrier:

1. Adjustable anchor foot type for above-the-floor no-hub piping connection for wall hung toilet.
2. Cast iron factory painted adjustable faceplate with corrosion-resistant adjustable waste coupling with neoprene seal and integral test cap.
3. Zinc plated steel fixture studs with vandal proof chrome plated fixture cap nuts and fiber fixture washers.
4. Josam 12674/12684/12694-VP, J.R. Smith series 0200, MIFAB series MC-10, Wade series W-311, Watts series ISCA-101, or Zurn series Z-1203-N-VP.
5. Arrangements shall be per the application.

2.7 URINALS

A. Urinal (1.0 GPF):

1. Vitreous china water saver (1.0 gallons per flush) siphon-jet, wall hung and with ¾" (top) inlet spud.
2. 2"IPS female threaded outlet (rear) connection and wall hanger.
3. Conforms to ASME Standard A112.19.2 fixture dimensions.
4. American Standard "Trimbrook", model 6561.017, Kohler "Freshman" model K-4989-T, or Zurn Z5730.

A. Urinal (0.5 GPF):

1. Vitreous china water saver (0.5 gallons per flush) siphon-jet, wall hung and with ¾" (top) inlet spud.
2. 2"IPS female threaded outlet (rear) connection and wall hanger.
3. Conforms to ASME Standard A112.19.2 fixture dimensions.
4. American Standard "Allbrook FloWise", model 6550.001, Kohler "Dexter" model K-5016-ET, Mansfield "Suburban" model 475HE, or Zurn Z5730 .

B. Urinal Pint Flush (0.125 GPF):

1. Vitreous china fixture, 0.125 gallons per flush washdown urinal, wall-mounted with ¾" (top) inlet spud.
2. 2" IPS female threaded outlet (rear) connection and wall hanger.
3. Conforms to ASME Standard A112.19.2 fixture dimensions.
4. American Standard "Washbrook FloWise" model 6590.125, Kohler "Dexter" model K-5452-ET-0, Mansfield "Cascade" model 410HE, Sloan model SU-1009, Toto UT445U, or Zurn Z5755-U.

2.8 URINAL: FLUSH VALVES

- A. Provide flush valve for each urinal furnished.
- B. Manual 1.0 GPF
 - 1. Diaphragm type, 1.0 gallons per flush manual closet flushometer.
 - 2. Metal oscillating non-hold-open handle.
 - 3. 3/4" IPS screw driver angle stop with protective cap.
 - 4. Adjustable tail piece.
 - 5. Vacuum breaker flush connection and spud coupling for 3/4" top spud, wall and spud flanges.
 - 6. Sloan model Royal 186-1.0, AMTC MF-700-U10, American Standard 6145101.002, or Zurn Z6003AV-WS1-VP.
 - 7. Sloan model Royal 186-1.0, no substitutions.
- C. Automatic, Battery Powered, 1.0 GPF:
 - 1. Diaphragm type, 1.0 gallons per flush urinal flushometer.
 - 2. Battery powered automatic "no hands" operation, chrome plated infrared sensor housing, angled sensor window.
 - 3. Manual override flush button.
 - 4. 3/4" I.P.S. screwdriver angle stop with vandal resistant stop cap.
 - 5. Adjustable tailpiece.
 - 6. Vacuum breaker flush connection, spud coupling and spud flange for 3/4" top spud.
 - 7. Valve shall be in compliance with the applicable sections of ANSI/ASME A112.19.2.
 - 8. Valve to be actuated by 6VDC solenoid.
 - 9. Sloan model G2 Optima Plus 8186-1.0 (Top Mounted), AMTC AEF-801-CU-10 (Top Mounted)
 - 10. Sloan model EBV500A, American Standard 6145SM101.002, or Zurn model ZR6003AV-WS1-VP (Side Mounted).
 - 11. Sloan "G2 Optima Plus" model 8186-1.0, no substitutions.
- D. Manual 0.5 GPF
 - 1. Diaphragm type, 0.5 gallons per flush manual closet flushometer.
 - 2. Metal oscillating non-hold-open handle.
 - 3. 3/4" IPS screw driver angle stop with protective cap.
 - 4. Adjustable tail piece.
 - 5. Vacuum breaker flush connection and spud coupling for 3/4" top spud, wall and spud flanges.
 - 6. Sloan Royal model 186-0.5, AMTC MF-700-U10, American Standard 6145051.002, or Zurn Z6003AV-EWS-VP
 - 7. Sloan Royal model 186-0.5, no substitutions.
- E. Automatic, Battery Powered, 0.5 GPF
 - 1. Diaphragm type, 0.5 gallons per flush urinal flushometer.
 - 2. Battery powered automatic "no hands" operation, chrome plated infrared sensor housing, angled sensor window.
 - 3. Manual override flush button.
 - 4. 3/4" I.P.S. screwdriver angle stop with vandal resistant stop cap.
 - 5. Adjustable tailpiece.
 - 6. Vacuum breaker flush connection, spud coupling and spud flange for 3/4" top spud.

7. Valve shall be in compliance with the applicable sections of ANSI/ASME A112.19.2.
8. Valve to be actuated by 6VDC solenoid.
9. Sloan model G2 Optima Plus 8186-0.5 or AMTC AEF-801-CU-05 (Top Mounted),
10. Sloan model EBV500A, American Standard 6145SM051.002, or Zurn model ZER6003-CPM-EWS-VP (Side Mounted).
11. Sloan model G2 Optima Plus 8186-0.5, no substitutions.

F. Manual 0.125 GPF

1. Diaphragm type, 0.125 gallons per flush manual closet flushometer.
2. Metal oscillating non-hold-open handle.
3. 3/4" IPS screw driver angle stop with protective cap.
4. Adjustable tail piece.
5. Vacuum breaker flush connection and spud coupling for 3/4" top spud, wall and spud flanges.
6. Sloan model Royal 186-0.125 or Zurn Z6003AV-ULF-VP.
7. Sloan model Royal 186-0.125, no substitutions.

G. Automatic, Battery Powered, 0.125 GPF

1. Diaphragm type, 0.125 gallons per flush urinal flushometer.
2. Battery powered automatic "no hands" operation, chrome plated infrared sensor housing, angled sensor window.
3. Manual override flush button.
4. 3/4" I.P.S. screwdriver angle stop with vandal resistant stop cap.
5. Adjustable tailpiece.
6. Vacuum breaker flush connection, spud coupling and spud flange for 3/4" top spud.
7. Valve shall be in compliance with the applicable sections of ANSI/ASME A112.19.2.
8. Valve to be actuated by 6VDC solenoid.
9. Sloan model Royal SMO 186-0.125, AMTC AEF-801-CU-18, American Standard 6145SM013.002, or Zurn model ZER6003AV-CPM-ULF-VP.
10. Sloan model ECOS 8186-0.125, no substitutions.

2.9 URINAL CARRIERS

A. Carrier:

1. Adjustable height universal plate hanger carrier with rectangular steel uprights
2. Block base anchor feet, upper and lower support plates, and vandal proof cap nuts.
3. Josam 17550-UR, J.R. Smith 0636, MIFAB MC-32, Wade W-401-AM1-M3, Watts CA-321, or Zurn model Z1222-58.

2.10 LAVATORIES

A. Countertop Lavatory - Wide Spread:

1. Vitreous china self-rimming countertop lavatory with faucet ledge, front overflow.
2. Nominal size: 20" Bx 17" oval.
3. Faucet holes on 8" centers.
4. Conforms to ASME Standard A112.19.2 for fixture dimensions.

5. American Standard model "AQUALYN" 0475.020, Kohler model "Pennington" K-2196-8-0, Mansfield "MS Oval" model 237-8, Sloan model SS3802, or Zurn model Z5118.
- B. Countertop Lavatory – Single Hole:
1. Vitreous china self-rimming countertop lavatory with faucet ledge, front overflow.
 2. Nominal size: 20" x 17" oval.
 3. Center hole only.
 4. Conforms to ASME Standard A112.19.2 for fixture dimensions.
 5. American Standard model "AQUALYN" 0475.047, Kohler model "Pennington" K-2196-1-0, Mansfield "MS Oval" model 237-1, Sloan model SS3102, or Zurn model Z5111.
- C. Wall Hung Lavatory:
1. Vitreous china with front overflow, faucet ledge, concealed carrier arms, self-draining deck area with contoured back and side splash shields.
 2. Nominal size: 20-1/2" x 18-1/4" with "D" shaped bowl.
 3. Faucet holes on 8" centers.
 4. Conforms to ASME Standard A112.19.2 for fixture dimensions.
 5. American Standard model "LUCERNE" 0356.015, Kohler "Kingston" model K-2006-0, Mansfield "Grand Isle" 2018HBNS-8, Sloan model SS-3803, or Zurn model Z5348.
- D. Undercounter Lavatory:
1. Vitreous china with front overflow, unglazed rim for undercounter mounting.
 2. Nominal size: 19 1/4" x 17" with oval shaped bowl.
 3. Conforms to ASME Standard A112.19.2 for fixture dimensions.
 4. American Standard model "Ovalyn" 0496.221, Kohler model "Caxton" K-2210-0, Mansfield "Maple" model 217, Sloan model SS-3001, or Zurn model Z5220.
- E. Undercounter Lavatory:
1. Stainless steel with front overflow, 18 gauge, for undercounter mounting.
 2. Nominal size: 18" x 14" with oval shaped bowl.
 3. Conforms to ANSI Standard A112.19.2 for fixture dimensions.
 4. Elkay model ELUH1511, Just model UOF-1619, or approved equivalent.
- F. Wall Hung, Wheel Chair Lavatory – Wide Spread:
1. Vitreous china with front overflow, slab type for concealed arm support.
 2. Nominal size: 27" x 20" with "D" shaped bowl.
 3. Faucet holes on 8" to 12" centers.
 4. Conforms to ASME Standard A112.19.2 for fixture dimensions.
 5. American Standard model "WHEELCHAIR USER'S LAVATORY" 9140.013, Kohler model "Morningside" K-12634-0, Mansfield Wheelchair model 315, Sloan model SS-3804, Zurn model Z5329.
- G. Wall Hung, Wheel Chair Lavatory – Single Hole:
1. Vitreous china with front overflow, slab type for concealed arm support.
 2. Nominal size: 27" x 20" with "D" shaped bowl.
 3. Single faucet hole.
 4. Conforms to ASME Standard A112.19.2 for fixture dimensions.
 5. American Standard model "WHEELCHAIR USER'S LAVATORY" 9140.047, Sloan model SS-3104, or Zurn model Z5321.

- H. Wall Hung, Wheel Chair Lavatory – Compact Wide Spread:
 - 1. Vitreous china with back overflow, wall type for concealed arm support.
 - 2. Nominal size: 20" x 22" with oval shaped bowl.
 - 3. Faucet holes on 8" centers.
 - 4. Conforms to ASME Standard A112.19.2 for fixture dimensions. Kohler model "Brenham" K-1997-8-0, with K-1998 Shroud, or approved equivalent.
- I. Wall Hung, Wheel Chair Lavatory – Compact Single Hole:
 - 1. Vitreous china with back overflow, wall type for concealed arm support.
 - 2. Nominal size: 20" x 22" with oval shaped bowl.
 - 3. Single faucet hole.
 - 4. Conforms to ASME Standard A112.19.2 for fixture dimensions.
 - 5. Kohler model "Brenham" K-1997-1-0, with K-1998 Shroud, or approved equivalent.
- J. Integral Lavatory:
 - 1. Lavatory shall be integrated into countertop and specified by Architect.
 - 2. Provide faucet and trim as designated.
- K. Solid Surface Multi-Station Lavatory:
 - 1. ADA compliant, wall-mounted two (2) station, solid surface with integral bowl, deck and ledge.
 - 2. Unit to include waste and supply connections to wall with stop, strainer, and check valves, integral infrared activated spray heads, thermostatic mixing valve assembly, and stainless steel support frame, concealed by high impact pedestal enclosure.
 - 3. Length: 60", Depth: 22" with two bowls.
 - 4. ADA and ANSI A117.1 compliant.
 - 5. Coordinate with Architect for color selections.
 - 6. Bradley model Express MG-2 or approved equal.
- L. Solid Surface Multi-Station Lavatory:
 - 1. ADA compliant, wall-mounted three (3) station, solid surface with integral bowl, deck and ledge.
 - 2. Unit to include waste and supply connections to wall with stop, strainer, and check valves, integral infrared activated spray heads, thermostatic mixing valve assembly, and stainless steel support frame, concealed by high impact pedestal enclosure.
 - 3. Length: 60", Depth: 22" with two bowls.
 - 4. ADA and ANSI A117.1 compliant.
 - 5. Coordinate with Architect for color selections.
 - 6. Bradley model Express MG-3 or approved equal.

2.11 LAVATORY FAUCETS

- A. Manual, Dual Handle:
 - 1. 8" centers.
 - 2. 5" spout.
 - 3. Vandal proof 0.5 GPM non-aerating spray outlet.
 - 4. Vandal proof metal lever handles, and color-coded index buttons.

5. Chicago Faucets model 404-200629AB , Delta model 3549LF-WFLGHDF, Kohler K-7307-KE/K-CP-16012-4, T&S Brass model B-2990-VF05, Zurn model Z831R1-XL-3M, or approved equivalent.
 6. Thermostatic temperature mixing valve OR
Hot and cold water supply check valves.
- B. Manual, Single Handle:
1. Single hole.
 2. 4-5/8" integral brass spout.
 3. Vandal proof 0.5 GPM non-aerating spray outlet, and color coded handle.
 4. Complies with ANSI A112.18.1.
 5. Chicago Faucets model 2200-E2805ABCP, T&S Brass B-2701-VF05 or Zurn Z82200-XL-3M.
 6. Thermostatic temperature mixing valve OR
Hot and cold water supply check valves.
- C. Manual, Single Handle:
1. 4" centers.
 2. 4-3/4" integral brass spout.
 3. Vandal proof 0.5 GPM aerator, and color coded single handle.
 4. Complies with ANSI A112.18.1.
 5. Chicago Faucets model 2200-4E2805ABCP, Delta model 511LF-HGMHDF, T&S Brass B-2711-VF05 or Zurn model Z81000-XL-3M.
 6. Thermostatic temperature mixing valve OR
Hot and cold water supply check valves.
- D. Manual, Metered:
1. Single hole.
 2. 3-3/8" integral brass spout.
 3. Vandal proof 0.5 GPM non-aerating spray outlet.
 4. Self-closing push button with adjustable cycle time.
 5. Complies with ANSI A112.18.1.
 6. Chicago Faucets model 333-E2805-665PSHAB, Delta model 87T110, T&S Brass B-0712 or Zurn model Z86100-XL-IN-3M.
 7. Thermostatic temperature mixing valve OR
Hot and cold water supply check valves.
- E. Manual, Metered:
1. 4" centers.
 2. 3-3/8" integral brass spout.
 3. Vandal proof 0.5 GPM non-aerating spray outlet.
 4. Self-closing push button with adjustable cycle time.
 5. Complies with ANSI A112.18.1.
 6. Chicago Faucets model 3600-E2805AB or approved equivalent.
 7. Thermostatic temperature mixing valve OR
Hot and cold water supply check valves.
- F. Wheel Chair :

1. 12" centers.
2. 5-3/8" gooseneck spout.
3. Vandal proof metal lever handles, color-coded index buttons.
4. 0.5 gpm vandal proof non-aerating spray outlet.
5. Zurn Z-831B1-XL-ICT-3F, Chicago 786-H series or equivalent by T&S Brass. Coordinate faucet with exact fixture purchased.
6. Thermostatic temperature mixing valve OR
Hot and cold water supply check valves.

2.12 LAVATORY ACCESSORIES

- A. Standard Strainer: 1-1/4" x 17 gauge cast brass grid strainer, integral spud and tailpiece.
 1. McGuire Mfg. model 155A, Dearborn Brass model 760-1, Just J-15-FS, or approved equivalent.
- B. Wheelchair Lavatory Strainer: 1-1/4" x 5" offset x 17 gauge cast brass grid strainer, integral spud and tailpiece.
 1. McGuire Mfg. model 155WC, Dearborn Brass model 760W-1, Just J-ADA-15-FS, or approved equivalent.
- C. Supplies: Loose keyed ball valve angle stops with lock shield caps and 1/2" (nominal) copper solder (5/8" ODS) inlet x 3/8" OD outlet x 12" long flexible risers.
 1. Provide cast brass escutcheons.
 2. Chicago Faucets model STB-41-11-AB, or approved equivalent by McGuire, Dearborn, Brass Craft, Engineered Brass, or Kohler.
- D. Trap: 1-1/2" x 1-1/4" x 17 gauge tubular P-trap with clean-out, plug and wall escutcheon.
 1. McGuire Mfg. model 8902, Dearborn Brass model 510, Just model JT-150, or approved equivalent.
- E. Trap primer tailpiece:
 1. 1-1/2" X 17 gauge tubular tail piece, chrome plated polished brass with cleanout with 1/2" compression fitting for stainless steel braided primer hose. Assembly shall include hose and wall escutcheon.
 2. Trap Primer shall be Dearborn Brass model 832-1, Precision Plumbing Products LTP-500, Zurn Z1021 or equivalent by McGuire or Just.
- F. Insulation Kit: Conforms to 28CFR Part 36, Article 4.19.4 (7/26/91).
 1. Truebro model LavGuard2, Dearborn Brass model ADA100, Just model J-ADA-150, or approved equivalent.
- G. Thermostatic mixing valve: ASSE 1070 compliant thermostatic temperature mixing valve with hot and cold water supply check valves.
 1. Equal to Acorn ST70, Symmons Maxline 8210-CK, or T&S Brass BP-TMV-38C.
- H. Standard Wall Hung Carrier:
 1. Adjustable concealed arm lavatory carrier with rectangular steel uprights and block base anchor feet.

2. Josam 17100, J.R. Smith 700-M31, MIFAB MC-41, Wade model W-520-M36, Watts WCA-411 or Zurn Z1231.

I. Wheel Chair Wall Hung Carrier:

1. Adjustable concealed arm lavatory carrier with rectangular steel uprights, block base anchor feet and extended arm supports.
2. Josam 17100-67, J.R. Smith 0700-27-M31, MIFAB MC-42, Wade catalog no. W-520-M24-M36, Watts CA-411-WC or Zurn Z-1231-79.

2.13 SINKS

A. Single Compartment, Countertop Size 1:

1. 18 gauge, type 304 stainless steel, self-rim single bowl sink.
2. Inside bowl dimensions: 16" L x 13 ½" W x 7 ½" D.
3. Faucet deck with 3 or 4 holes (per the Faucet schedule) on 4" centers.
4. Elkay model LR-1919, Acorn SD-2019-80-0, Just SL-2019-A-GR, or equivalent by Advance Tabco, Amteko Wasserstrom or Franke.

B. Single Compartment, Countertop Size 2:

1. 18 gauge, type 304 stainless steel, self-rim single bowl [ADA compliant] sink.
2. Inside bowl dimensions: 21" L x 15 ¾" W x 8" [6 ½" for ADA compliant] D.
3. Faucet deck with [3 or 4] holes on 4" centers.
4. Elkay model LR-2522 [LRAD-252265], Acron SD-2522-80-0, [SDAD-2522-55-0], Just SL-2225-A-GR [SL-ADA-2225-A-GR], or equivalent by Advance Tabco, Amteko Wasserstrom, or Franke.

C. Single Compartment, Countertop Size 3

1. 18 gauge, type 304 stainless steel, self-rim single bowl sink.
2. Inside bowl dimensions: 21" L x 15 ¾" W x 10" D.
3. Faucet deck with 3 or 4 holes (per the Faucet schedule) on 4" centers.
4. Elkay model DLR-252210 or Just SLX-2225-A-GR, or equivalent by Acorn, Advance Tabco, Amteko Wasserstrom, or Franke.

D. Double Compartment, Countertop:

1. 18 gauge, type 302 stainless steel, self-rim double bowl sink.
2. Overall dimensions 33" x 22".
3. Inside bowl dimensions: 16" L x 13 ½" W x 8" D.
4. Faucet deck with [3 or 4] holes on 4" centers.
5. Elkay model LR-3322, Acorn DD-3322-80-0, Just DLF-2233-A-GR, or equivalent by Advance Tabco, Amteko Wasserstrom, or Franke.

E. Single Compartment, Undermount Size 1:

1. 18 gauge, type 304 stainless steel, self-rim single bowl sink.
2. Inside bowl dimensions: 16" L x 13 ½" W x 7 ½" D.
3. Elkay model ELUH1316, Acorn SU-2116-80, Just US-1816-A, or equivalent by Advance Tabco, Amteko Wasserstrom, or Franke.

F. Single Compartment, Undermount Size 2 :

1. 18 gauge, type 304 stainless steel, self-rim single bowl [ADA compliant] sink.

2. Inside bowl dimensions: 21" L x 15 3/4" W x 7 1/2" [6 1/2"] D.
 3. Elkay model ELUH2115 [ELUH-211555], Acorn SU-2116-80, Just US-1824-A [US-ADA-1824-A], or equivalent by Advance Tabco, Amteko Wasserstrom, or Franke.
- G. Single Compartment, Undermount Size 3
1. 18 gauge, type 304 stainless steel, self-rim single bowl sink.
 2. Inside bowl dimensions: 21" L x 15 3/4" W x 10" D.
 3. Elkay model ELUH211510 or Just USX-1824-A, Advance Tabco 1620A-10, or equivalent by Acorn, Amteko Wasserstrom or Franke.
- H. Double Compartment, Undermount:
1. 18 gauge, type 302 stainless steel, self-rim double bowl sink.
 2. Overall dimensions 31" x 18".
 3. Inside bowl dimensions: 16" L x 13 1/2" W x 8" D.
 4. Faucet deck with [3 or 4] holes on 4" centers.
 5. Elkay model ELUH3118, Acorn DU-3118-80, Just UDF-1832-A, or equivalent by Advance Tabco, Ameteko Wasserstrom, or Franke.
- I. Stainless Steel, Wall Hung:
1. 18 gauge, type 302 stainless steel, self-rim single bowl sink.
 2. Inside bowl dimensions: 12" L x 9 1/4" W x 6" D.
 3. Elkay model CHS-1716, Advance Tabco 7-PS-70, or equivalent by Amteko Wasserstrom, Franke, or Just.
- J. Scullery:
1. 14 gauge, type 300 stainless steel, 14" deep bowls welded 1/4" radius coved corners, channel rim with full 8" high backsplash, polished finish.
 2. Sink shall be supported by four 1 5/8" tubular, 16-gauge stainless steel legs with bullet feet.
 3. [Customize the size, number of bowls, drain boards, faucet drillings, etc.]
 4. Elkay Model Weldbilt WNSF-XXXX Just NSFB-XXX, or equivalent by Acorn, Advance Tabco, Ameteko Wasserstrom, or Franke.
- 2.14 SINK ACCESSORIES
- A. Strainer: Provide stainless steel crumb basket with rubber stop for 3-1/2" drain opening and 1-1/2" OD brass tailpiece for each sink bowl, that does not have a disposal.
1. Elkay model No. LK-35, Just J-35, or Advance Tabco K-310.
- B. Supplies: Loose keyed ball valve angle stops with lock shield caps and 1/2" (nominal) copper solder (5/8" ODS) inlet x 3/8" OD outlet x 12" long flexible risers.
1. Provide cast brass escutcheons.
 2. Chicago Faucets model STB-41-11-AB, no substitution or approved equivalent by McGuire, Dearborn, Brass Craft, Engineered Brass, or Kohler.
- C. Trap: 1-1/2" x 17 gauge tubular P-trap with cleanout plug and wall escutcheon.
1. McGuire Mfg. model 8912, Dearborn Brass model 710-1, Just model JT-150, or approved equivalent.

2.15 SINK FAUCETS:

- A. Swing Spout, Dual Handle:
 - 1. Polished chrome.
 - 2. 8" centers
 - 3. 8" L-type swing spout.
 - 4. Vandal proof 1.5 GPM aerator.
 - 5. Lever handles.
 - 6. Complies with ANSI A112.18.1.
 - 7. Chicago Faucets model 201-209700AB , Kohler K-7761-K/K-16012-4, T&S Brass B-2854-CR ,or Zurn Z-831J1-X.
- B. Small Gooseneck, Lever Handles:
 - 1. Polished chrome.
 - 2. 8" centers.
 - 3. 5-3/8" swing gooseneck spout.
 - 4. Vandal proof 0.5 GPM non-aerating spray outlet.
 - 5. Vandal proof metal lever handles.
 - 6. Complies with ANSI A112.18.1.
 - 7. Chicago Faucets model 786-204630AB T&S Brass B-2850-CR-VRS T&S Brass or Zurn series Z831B1-XL-3F.
- C. Small Gooseneck, Wristblade Handles:
 - 1. Polished chrome.
 - 2. 8" centers.
 - 3. 5-3/8" swing gooseneck spout.
 - 4. Vandal proof 0.5 GPM non-aerating spray outlet.
 - 5. Vandal proof metal wristblade handles.
 - 6. Complies with ANSI A112.18.1.
 - 7. Chicago Faucets model 786-E72KXABCP T&S Brass B-2850-CR-VRS-WH4 or Zurn series Z831B4-3F.
- D. Large Gooseneck, Lever Handles:
 - 1. Polished chrome.
 - 2. 8" centers.
 - 3. 8" swing gooseneck spout.
 - 4. Vandal proof 2.2 GPM aerator.
 - 5. Vandal proof metal lever handles.
 - 6. Complies with ANSI A112.18.1.
 - 7. Chicago Faucets model , T&S Brass or Zurn model Z831C1-XL-3F.
- E. Large Gooseneck, Wristblade Handles:
 - 1. Polished chrome.
 - 2. 8" centers.
 - 3. 8" swing gooseneck spout.
 - 4. Vandal proof 2.2 GPM aerator.
 - 5. Vandal proof metal wristblade handles.
 - 6. Complies with ANSI A112.18.1.
 - 7. Chicago Faucets model 786-GR8AE3V317XKAB T&S Brass B-2862-CR-VRS with BL-5550-31 or Zurn model Z831C4-XL-3F.

F. Small Gooseneck, Side Valve Single Handle:

1. Polished chrome.
2. 5-3/8" swing gooseneck spout.
3. Vandal proof 0.5 GPM non-aerating spray outlet.
4. Hot and cold water mixing valve.
5. Metal lever handle.
6. Complies with ANSI A112.18.1.
7. Chicago Faucets model. 2302-E2805-5ABCP, T&S Brass model B2742, or Zurn Z824B0-XL-3F.

G. Utility Sink Faucet:

1. Polished chrome.
2. 6" centers, vacuum breaker rigid spout with 3/4" hose thread outlet.
3. Wall brace and pail hook.
4. 1/2" F union inlets on exposed valves.
5. Lever handles, indexed and tabbed for "HOT" and "COLD".
6. [Chicago Faucets model 835-369CP for overhead supplies. Chicago Faucets model 540-LD897SGXKCCP or Zurn Z841M1 for supplies thru-the-wall.]

H. Wall Mounted Double-Jointed:

1. Polished chrome.
2. Adjustable center 4" to 8-3/8", H supply arms.
3. 13" double jointed swing spout.
4. 1.5 GPM aerator.
5. Metal lever handles.
6. Complies with ANSI A112.18.1.
7. Chicago Faucets model 445-D222213AB T&S Brass B-0235-CR-LN with 066X-A22DJ Spout or Zurn model Z-841K1-XL.

2.16 SERVICE SINK: ENAMELED CAST IRON (SS):

A. Service Sink:

1. Enameled cast iron, acid resisting with wall hanger and rim guard.
2. Nominal size: 24" x 20" faucet holes on 8" centers through back.
3. Conforms to ANSI Standard A112.19.1M for fixture dimensions.
4. American Standard model "AKRON" 7695.008, Kohler model Bannan K-6716-0, or Zurn model Z5898.

B. Faucet:

1. Polished chrome.
2. 8" centers.
3. 8" vacuum breaker rigid spout with 3/4" hose thread outlet.
4. Lever handles.
5. Wall brace and pail hook.
6. 1/2" FPT inlets with flanges.
7. Chicago Faucets model 540-LD897SGXKCCP.

C. Supplies:

1. Loose keyed angle stops with lock shield caps and ½" (nominal) copper solder (5/8" ODS) inlet x 1/2" OD outlet x 12" long flexible risers.
2. Provide cast brass escutcheons.
3. Chicago Faucets model 1027-ABCP, or approved equivalent by McGuire, Dearborn, Brass Craft, Engineered Brass, or Kohler.

D. Strainer: Include with trap.

E. Trap:

1. 3" cast iron threaded connection with removable perforated grid.
2. American Standard model 7798.030, Kohler K-6673, or Zurn Z5900-IP3..

F. Carrier:

1. Sink carrier with rectangular steel uprights, welded feet, adjustable support plate, and mounting fasteners.
2. Josam 17550, J.R. Smith 0800, MIFAB MC-31, Wade W-404-M36, Watts CA-421, or Zurn Z-1224.

2.17 MOP SINK BASIN: (MSB):

A. Receptor (basin):

1. 24" x 24" x 12" high, precast terrazzo one-piece basin, ground smooth, grouted and sealed to resist stains.
2. Top edge capped with 20-gauge type 302 stainless steel cast integrally on all four sides.
3. corn model TSH-24-SSC-KH36-KWG, Fiat model TSB-100, or Stern Williams model "SERVICEPTOR" SB-900.

OR

1. 24" x 36" x 12" high, precast terrazzo one-piece basin, ground smooth, grouted and sealed to resist stains.
2. Top edge capped with 20-gauge type 302 stainless steel cast integrally on all four sides.
3. Acorn model TSH-3624-SSC-KH36-KWG, Fiat model TSB-700, or Stern Williams model "SERVICEPTOR" SB-250.

B. Faucet:

1. Polished chrome.
2. Vacuum breaker rigid spout with ¾" hose thread outlet.
3. Wall brace and pail hook.
4. ½" F union inlets on exposed valves on 6" centers.
5. Lever handles, indexed and tabbed for "HOT" and "COLD".
6. Chicago Faucets model 835 for overhead supplies. Chicago Faucets model 540-LD897SGXKCCP or Zurn Z841M1 for supplies thru-the-wall.
7. Provide cold water hose bibb (HB-A) with RPZ backflow preventer for chemical mixer.
8. Pipe drain from RPZ to sink.

C. Strainer: Cast brass outlet with stainless steel strainer cast integrally into bottom of basin to provide for an inside caulk connection for a 3" waste pipe.

- D. Splash Panels: Provide 20 gauge 302 stainless steel sheet splash catcher panels on one or two sides as required.
- E. Accessories: Provide 3/6" hose and hose wall bracket.

2.18 ELECTRIC WATER COOLER: BI-LEVEL, SEMI-RECESSED W/ BOTTLE FILLER:

- A. Semi recessed, refrigerated, bi-level for general public and ADA usage with bottle filling station.
 - 1. Lower unit shall be wheelchair accessible.
 - 2. Bubbler shall be activated by mechanical push-button and have built-in pressure regulator for supply pressure range from 20 to 125 psi.
 - 3. All exposed surfaces shall be satin-finish type 304 stainless steel.
 - 4. Furnish mounting wall box and cover grille.
 - 5. All waterway components shall be copper construction with lead-free connections.
 - 6. Refrigeration system shall be air-cooled; chill the drinking water in a storage tank type heat exchanger; have an adjustable thermostatic control; be rated to cool 8 gph from 80 deg. F to 50 deg. F at 90 deg. F room temperature.
 - 7. Certified by ARI, UL and CSA and comply with all local building codes and ADA Requirements.
 - 8. Elkay model EZWS-SS28K, or Halsey Taylor model. HTHB-HRF SER.
- B. Semi recessed, filtered, refrigerated, bi-level for general public and ADA usage with bottle filling station.
 - 1. Lower unit shall be wheelchair accessible.
 - 2. Bubbler shall be activated by mechanical push-button and have built-in pressure regulator for supply pressure range from 20 to 125 psi.
 - 3. All exposed surfaces shall be satin-finish type 304 stainless steel.
 - 4. Furnish mounting wall box and cover grille.
 - 5. All waterway components shall be copper construction with lead-free connections.
 - 6. Refrigeration system shall be air-cooled; chill the drinking water in a storage tank type heat exchanger; have an adjustable thermostatic control; be rated to cool 8 gph from 80 deg. F to 50 deg. F at 90 deg. F room temperature.
 - 7. Certified by ARI, UL and CSA and comply with all local building codes and ADA Requirements.
 - 8. Elkay model LZWS-SS28K, Halsey Taylor model. HTHBWF-HRF SER, or Oasis model no. M8CREBF.
- C. For masonry construction applications, Plumbing Contractor will mount water cooler directly to wall using factory supplied mounting box.
- D. For non-masonry applications, provide and mount using Josam 17550-WCBL, J.R. Smith 0830, MIFAB MC-31, Wade W-403-BL-M36, Watts CA-431-1, or Zurn 1225-BL.

2.19 ELECTRIC WATER COOLER: BI-LEVEL, WALL MOUNTED WBOTTLE FILLER:

- A. Wall mounted, refrigerated, bi-level for general public and ADA usage with bottle filling station.
 - 1. Lower unit shall be wheelchair accessible.

2. Bubbler shall be activated by mechanical push-button and have built-in pressure regulator for supply pressure range from 20 to 125 psi.
 3. All exposed surfaces shall be satin-finish type 304 stainless steel.
 4. Furnish mounting wall box and cover grille.
 5. All waterway components shall be copper construction with lead-free connections.
 6. Refrigeration system shall be air-cooled; chill the drinking water in a storage tank type heat exchanger; have an adjustable thermostatic control; be rated to cool 8 gph from 80 deg. F to 50 deg. F at 90 deg. F room temperature.
 7. Certified by ARI, UL and CSA and comply with all local building codes and ADA Requirements.
 8. Elkay model EMABFTL8WSSK, Halsey Taylor model HTHB-HAC8BLSS-NF, or Oasis model PGF8EBFSL.
- B. Wall mounted, refrigerated, vandal resistant, bi-level for general public and ADA usage with bottle filling station.
1. Lower unit shall be wheelchair accessible.
 2. Bubbler shall be activated by mechanical push-button and have built-in pressure regulator for supply pressure range from 20 to 125 psi.
 3. All exposed surfaces shall be satin-finish type 304 stainless steel.
 4. Furnish mounting wall box and cover grille.
 5. All waterway components shall be copper construction with lead-free connections.
 6. Refrigeration system shall be air-cooled; chill the drinking water in a storage tank type heat exchanger; have an adjustable thermostatic control; be rated to cool 8 gph from 80 deg. F to 50 deg. F at 90 deg. F room temperature.
 7. Certified by ARI, UL and CSA and comply with all local building codes and ADA Requirements.
 8. Elkay model VRCTL8WSK, Halsey Taylor model HTHBHVR8BL-NF, or Oasis model PGV8EBF with PGVAC fountain.
- C. For masonry construction applications, Contractor shall mount water cooler directly to wall using factory supplied mounting box.
- D. For non-masonry applications, provide and mount using Josam 17550-WCBL, J.R. Smith 0830, MIFAB MC-31, Wade W-403-BL-M36, Watts CA-431-1, or Zurn 1225-BL.

2.20 EMERGENCY EYE/FACE WASH – EXPOSED

- A. Combination eye/face wash station shall comply with ANSI Z358.1.
1. 10" diameter ABS plastic or stainless steel eyewash bowl.
 2. 1/2" stay-open ball valve with hand operated paddle push handle.
 3. ABS or epoxy coated steel pipe.
 4. 3.7 gpm flow control for eye/face wash.
 5. Unit shall be floor mounted and wall anchored, barrier-free, accessible.
 6. [Unit shall be provided with a ASSE 1071 compliant thermostatic mixing valve.]
 7. Acorn model S0320-BF, Bradley model S19214, Guardian Equipment model GBF1704, Haws model 7261-7271, Speakman SE-490/491, or Stingray S2515-EP.

2.21 EMERGENCY EYE/FACE WASH – CONCEALED

- A. Combination eye/face wash station shall comply with ANSI Z358.1.
 - 1. ABS wash spray heads.
 - 2. ½” stay-open ball valve with hand operated paddle push handle.
 - 3. 3.7 gpm flow control for eye/face wash.
 - 4. Unit shall be recessed wall mounted, swing down, barrier free unit with stainless steel cabinet and wall anchored.
 - 5. [Unit shall be provided with a ASSE 1071 compliant thermostatic mixing valve.]
 - 6. Acorn model S0560, Bradley model S19284JB, Guardian Equipment model G1735, Haws model 7656WCC, or Stingray model S2575-NFT.

2.22 EMERGENCY EYEWASH/DRENCH HOSE – WALL MOUNTED

- A. Wall mounted, hand-held drench hose/eye wash shall be fully factory assembled and hydrostatically tested to meet or exceed ANSI Z358.1,
 - 1. ½” IPS U.S. made chrome plated brass squeeze valve with renewable stainless steel seat and locking clip.
 - 2. Stainless steel handle with plastic cover.
 - 3. Insulator handle.
 - 4. Powder coated wall bracket, and 12ft. nylon coiled hose.
 - 5. Unit shall have polypropylene spray head(s) with integral “flip-top” dust covers, filters.
 - 6. 3.7 -GPM flow control orifices mounted on a chrome plated brass eyewash assembly.
 - 7. Unit shall include ANSI compliant sign and come with a full 2-year warranty.
 - 8. Unit shall be provided with [a ASSE 1071 compliant thermostatic mixing valve and] integral backflow preventer.
 - 9. Acorn model S0406-CH12-BFP, Bradley S1944011BBC/S27-303, Guardian Equipment G5046BP, Speakman SE-920, or approved equivalent.

2.23 EMERGENCY EYEWASH/DRENCH HOSE – DECK MOUNTED

- A. Deck mounted, hand-held drench hose/eye wash shall be fully factory assembled and hydrostatically tested to meet or exceed ANSI Z358.1.
 - 1. ½” IPS U.S. made chrome plated brass squeeze valve with renewable stainless steel seat and locking clip.
 - 2. Stainless steel handle with plastic cover.
 - 3. Insulator handle.
 - 4. Powder coated wall bracket, and 8 ft. nylon coiled hose.
 - 5. Unit shall have two (2) polypropylene spray heads with integral “flip-top” dust covers, filters.
 - 6. 1.8-GPM flow control orifices mounted on a chrome plated brass eyewash assembly.
 - 7. Unit shall include ANSI compliant sign and come with a full 2-year warranty.
 - 8. Unit shall be provided with [a ASSE 1071 compliant thermostatic mixing valve and] integral backflow preventer.
 - 9. Acorn model S0706-BFP, Bradley S19-460EFW/S27-303, Guardian Equipment G5022BP-FSH, Speakman SE-927, or approved equivalent.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Provide stops (valves) in all water supplies to all fixtures.
- B. Provide templates of openings required for countertop mounted fixtures to the General Contractor.
- C. Connections between plumbing fixture outlets and respective waste piping shall be gas and watertight. Use suitable and approved setting compound or gasket; rubber gaskets or putty are not acceptable.
- D. Plumbing Fixture Installation:
 - 1. Install fixture level and plumb according to roughing-in drawings.
 - 2. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
 - 3. Provide carriers or appropriate mounting frame for each wall hung or recessed fixture furnished.
- E. Floor Sink Installation:
 - 1. Install floor sink at appropriate depth for top to be flush with flooring.
 - 2. Field cut grate top as required for drainage terminations.
 - 3. Provide with trap guard.
- F. Water-Closet Installation:
 - 1. Provide toilet seat for each water closet.
 - 2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
 - 3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
 - 4. Floor mounted water closets shall be installed with a cast iron flange equivalent to Zurn CF2980. The flange shall be securely anchored to the floor. Provide wax ring for toilet installation.
- G. Urinal Installation:
 - 1. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
 - 2. Install wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
 - 3. Indicate on Drawings those urinals that are required to be accessible.

4. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC A117.1.
 5. Install trap-seal liquid in waterless urinals.
- H. Lavatory Installation:
1. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories.
 2. Anchor wall-mounted fixture to supports.
 3. Install countertop or undermount lavatories in countertop with appropriate support accessories.
- I. Sink Installation:
1. Install countertop or undermount sinks in countertop with appropriate support accessories.
 2. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks.
- J. Drinking Fountain, Cuspidor and Electric Water Cooler Installation:
1. Set freestanding, fixtures on floor.
 2. Anchor wall-mounted or recessed fixtures to supports.
- K. Support Installation:
1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
 2. Use carrier supports with waste-fitting assembly and seal.
 3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
 4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
 5. Use off-floor carriers with waste fitting and seal for back-outlet urinals or wall mounted drinking fountains, cuspidors and electric water coolers.
 6. Use carriers without waste fitting for urinals with tubular waste piping.
 7. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
 8. Install supports, affixed to building substrate, for wall-hung fixtures.
 9. Install mounting frames, affixed to building construction, and attach recessed fixtures to mounting frames.
 - 10.
- L. Flushometer-Valve Installation:
1. Install flushometer-valve, water-supply fitting on each supply to each water closet and urinal.
 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
 3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
 4. Furnish transformer(s) as required for a group application of hard-wired water closets, urinals, and faucets.
- M. Shower Installation:
1. Assemble shower components according to manufacturers' written instructions.
 2. Install shower flow-control fittings with specified maximum flow rates in shower arms.
 3. Set shower receptors in leveling bed of cement grout.

- N. Emergency Fixture Installation:
 - 1. Assemble emergency plumbing fixture piping, fittings, control valves, and other components
 - 2. Anchor or fasten fixtures to building substrate.
 - 3. Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
 - 4. Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
 - 5. Fill self-contained fixtures with flushing fluid.
- O. Wall Flange and Escutcheon Installation:
 - 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
 - 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
- P. Joint Sealing:
 - 1. Seal joints between fixtures and walls, counters, and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 - 2. Match sealant color to fixture color.
 - 3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- Q. Piping Connections: Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- R. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

3.3 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Operate and adjust fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Install new batteries in battery-powered, electronic-sensor mechanisms.
- C. Adjust fixture flow regulators for proper flow and stream height for all drinking fountains, urinals and electric water coolers..
- D. Adjust electric water-cooler temperature settings.
- E. Adjust water pressure at shower valves to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. Clean fixtures and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed fixtures and fittings.
- C. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 40 00

SECTION 22 50 00 – PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Domestic water circulating pumps
 - 2. Domestic water storage tanks – jacketed
 - 3. Electric domestic water heater
 - 4. Elevator sump pump
 - 5. Simplex sump pump – submersible
 - 6. Water softener
- B. Related Requirements:
 - 1. Section 22 00 00 PLUMBING WORK

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

2.2 DOMESTIC WATER CIRCULATING PUMP

- A. Domestic hot water circulating pump shall be lead free all bronze body with bronze impeller, line mounted, with capacities as scheduled. Refer to Division 23 21 40 for equivalent models to the scheduled pump.

OR

- B. Domestic hot water circulating pump shall be stainless steel with impact modified PPE impeller, line mounted, with capacities as scheduled. Bell & Gossett model ecocirc XL or 20-18 as scheduled, or approved equivalent by Armstrong or Grundfos.

2.3 DOMESTIC WATER STORAGE TANK - JACKETED

- A. The domestic water storage tank shall be vertical, ASME labeled for 125 psi operating pressure and shall be provided with mounting saddles, magnesium anode, manhole and tappings as required. The tank shell shall be not less than 11/32" steel; heads not less than 9/32" steel. The exterior of the tank shall be painted with a rust resistant shop primer. The interior of the tank shall be sandblasted and glass lined, A.O. Smith Permaglas Model [TJV-____], Lochinvar, or Niles. Only tanks with glass lined or copper interiors will be accepted. See Schedule on drawings for sizes and quantities.

OR

- B. The hot water storage tank shall be vertical, ASME labeled for minimum 150 psi operating pressure and shall be provided with mounting saddles, manhole and tappings as required. The exterior of the tank shall be painted with a rust resistant shop primer. The interior of the tank shall be unlined and made of phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum 21% chromium to prevent corrosion. Tank shall comply with NSF 61 and meet ASHRAE 90.1. PVI Aquaplex Storage Tank or approved equal. See Schedule on drawings for sizes and quantities.
- C. Tank shall have a minimum of R-12.5 high density insulation and shall comply with the current edition of ASHRAE standard 90.1, and Department of Energy requirements.
- D. Jacket shall be heavy gauge steel with powder coat paint finish.

2.4 DOMESTIC WATER BOOSTER PUMP

- A. All materials that may come in contact with the potable water delivered shall comply with ANSI/NSF Standard 61 and the "complete system" shall be certified as constructed. Individual component certification is not compliant.
- B. Pressure ratings of pumps, pipe, fittings, valves, gauges and all other water carrying appurtenances shall be a minimum of 150 psi operating pressure.
- C. All components of the system shall be compatible and be furnished by a single source manufacturer and all electrical services and interconnecting equipment wiring must be provided for a complete assembly with a single-source, fused power disconnect and water connections.

- D. The entire system shall be factory skid mounted on a minimum 304 stainless-steel structural square tube support frame, with in-shear molded rubber vibration isolators in compliance with standards as required in installation instructions published by pump manufacturer. Suction and Discharge Headers must be supported by pump skid frame to prevent piping strain on the pump casing and during system transport. No Exceptions.
- E. System must meet ANSI/ASHRAE/IES 90.1, Section 10.4.2, Energy Standard for Buildings and have proof of compliance utilizing either remote sensor option or software logic which adjusts set point according to flow rate.
- F. All valves shall be full port bronze ball valves with integral union, stainless steel ball and stem design for valve sizes 2" and smaller, and ductile iron, epoxy coated, lever operated, lug or grooved style type butterfly valves, with stainless steel disc, and stainless steel shaft, for valve sizes 2.5" and larger. Valves must be rated for maximum pressure service for the system and comply with NSF 61 Drinking Water requirements.
- G. Unions or flanges shall be provided for easy removal of pumps. System headers shall be sized for a velocity not exceeding 10 FPS at full flow and shall be terminated with a groove or flanged joint capable of accepting a groove coupling ANSI flange or groove flange furnished by Contractor.
- H. The packaged pumping system shall include all electrical wiring between components and shall be completely flow and pressure tested for actual site conditions at the factory prior to shipment.
- I. System shall be arranged such that single point connections are required for piping and electrical power supply.
- J. Individual pumps, motors and check valves shall be serviceable with the booster system in operation utilizing isolation valves for each pump.
- K. Pumps: System shall include vertical stainless steel, split-coupled, multi-stage pumps with ANSI flanged connections. Pump features to include stainless steel canister, bowl and diffuser stack, bottom centerline discharge and hydraulically balanced stainless steel impeller(s) with silicon carbide on carbon/EPDM seal minimum. Pump shall be designed for maximum efficiency with stainless steel fitted construction and a replaceable seal via a split coupling back pull-out, cartridge design. Pumps and motors larger than 5 H.P. shall be mounted with rubber-in-shear isolators to reduce vibration to the machine and system piping as required.
- L. Motors and Variable Frequency Drives: See Division 20.
- M. Pressure Sensor/Transmitter: Provide suction and discharge, stainless steel pressure sensors/transmitters which provide a 0-10 VDC signal output, compatible with the system controls, temperature and pressure requirements. Pressure sensor/transmitter shall have zero, span and damping devices. The transmitter shall be installed on the system suction and discharge headers and factory wired to the control circuitry. Sensor shall feature a high contrast LED readable from a 6-foot distance by maintenance personnel. When high-contrast LED transmitters are provided, other gauges or sensors are redundant and un-necessary.
- N. Sequence of Operation:
 - 1. The lead pump shall run only as necessary to maintain system pressure and will be controlled automatically by means of the pressure sensor/transmitter and programmable logic controller (PLC) designed to prevent short cycling and provide sensor-less flow

detection. If the lead pump is unable to maintain system pressure the lag pump(s) will be called on as required by the sensor-less flow algorithm and will operate in parallel with the lead pump until no longer necessary and be sequenced off. When one pump can handle the system demand the controls will optimize energy consumption by eliminating the lag pump from sequence. When a low or no-flow condition is reached, the system shall revert to the stand-by mode when no flow is present via an intelligent flow detection algorithm, which does not raise the set pressure to charge a tank to detect low flow. These systems DO NOT require a hydro-pneumatic tank installed. (See 2.08) Note: Raising system pressure to charge a tank violates ANSI/ASHRAE/IES Standard 90.1 by raising the pressure in lieu of maintaining constant system pressure.

2. An empty pipe condition is to be determined by an algorithm allowing for a slow ramp to set point to prevent system pressure shocks. The “pipe-fill” algorithm will also prevent VFD “wind-up” and pressure spikes associated with this condition.
3. The system shall employ software to detect pipe break and stop system, initiate an alarm and log the event. In the event of a sensor failure, the system shall run one pump in a semi-automatic mode allowing the building to maintain a minimum pressure until the sensor can be repaired or replaced.
4. An auto-tuning PID algorithm shall continuously monitor system pressure and maintain steady-state system pressure as demand load changes rapidly and pump moves horizontally on its plumbing-performance curve. The PID algorithms shall incorporate intelligent algorithms to start the pumps at the point of creating pressure saving energy and reducing time to set pressure upon pump call.

O. Control Panel:

1. Logic Section - Provide, mount and wire on the skid a programmable logic controller in a NEMA 3R, splash-proof, forced-air ventilated enclosure to fully contain all VFD's and interface the signal from the pressure sensor to the VFD's and provide a stabilized response to speed up or slow down or add pumps to meet system requirements. The controller shall provide set point adjustment, timer adjustment, PID functions (as required) and both system and controller self-diagnostics via touch screen display. The touch screen display/human machine interface shall include a 7" TFT WVGA, 16.7 million color, resistive analog display. All user interface set points shall be easily accessible via a password protected display screen. The password shall be of the “rolling” type to prevent un-authorized access to factory settings. Normal system operation shall be auto-tuned to eliminate hunting. Controller shall feature a USB Download connection which allows user to download trending analysis without the need for a formal BAS connection. All system data and settings shall be accessible from the display without the need to access the high-voltage controller internals. The software shall include clear alarm indications and user wizards to ascertain and correct typically encountered system alarms.
2. Power Section – The internally touch-safe, high voltage controller with HMI shall be factory wired and mounted on the stainless steel system skid. The panel shall be furnished with single-point, fused main disconnect switch with through the door handle, each VFD shall be protected by a fused branch compact circuit protector. A 24-volt DC power supply shall be provided for logic, sensors and fan circuitry where necessary. Controller shall feature the following minimum additional components:
 - a. Type II Surge Arrestor with active over-voltage control via metal oxide varistors. Passive surge arrestors are not acceptable.
 - b. Low suction pressure shutdown circuit with auto reset and alarm logging.
 - c. High system pressure shutdown circuit with auto reset and alarm logging.

- d. System key-logger which records the last 400 keypad entries stored in non-volatile memory. (downloadable)
 - e. Audible alarm with silence push button and alarm log recognition of reset.
 - f. Auto-alternate all pumps automatically on each stand-by cycle.
 - g. Auxiliary relay contacts for all alarm conditions or discreet data monitoring capability.
 - h. Audible and visual indication of low storage tank level, with silence push button. (when optional suction break-tank is used)
 - i. Elapsed time meters, motor voltage, KW and other critical values, portable to system SCADA via discreet communication.
 - j. Pipe Break Alarm with auto-shut down and time/date alarm logging of event.
 - k. Trend chart indicating system pressure and system KW with direct to USB Flash download for the most recent 1-week events, time and date stamped.
 - l. The system shall not require external flow meters or KW monitoring. The system will not implement speed, thermal or time delay means to detect and shut down pumps on a no demand condition as this wastes energy and provides for unnecessary run times.
 - m. System must feature ANSI/ASHRAE/IES Energy Standard 90.1 compliance via either a remote mounted pressure sensor or internal system logic which detects low flow and automatically adjusts set point according to piping losses at the condition with auto reset.
 - n. As per current NEC 2017, Section 409.110, control panel MUST have a listed minimum SCCR value, equal to or greater than the available fault current of the feeder circuit. A coordination study must be completed and furnished by the electrical designer or contractor to verify available fault current against the connected equipment.
3. Pump shall be Quantum Flo, Armstrong, Bell & Gossett, Grundfos, Hyfab, Tigerflow, or approved equivalent

2.5 ELECTRIC DOMESTIC WATER HEATER

- A. Tank shall be steel, rated for 150 psi working pressure, all internal surfaces exposed to water shall be glass lined, insulated with foam insulation, exceeding ASHRAE 90.1., covered with a minimum 16 ga. outer jacket, and have baked enamel finish.
- B. Heater shall have an ASME pressure/temperature relief valve, replaceable magnesium anode rods, non-metallic dip tube, and drain valve with hose end and cap.
- C. Each heating element shall be controlled by an individually mounted thermostat and high temperature cut-off switch.
- D. Heating tank shall have a three year warranty.
- E. Water heater shall meet or exceed the capacity scheduled. Provide heater by A.O. Smith, or approved equivalent from Bock, Bradford White, Heat Transfer Products, Lochinvar, Ruud or State Industries.

2.6 ELEVATOR SUMP PUMP

- A. Furnish and install where shown on the plans an elevator sump pump complete with pump, oil sensing pump control switch, high alarm float, and high water alarm panel.
- B. Pump shall be non-clog centrifugal, submersible, vertical sump pump. Pump shall be high quality gray cast iron ASTM A-48, class 30 construction. Impeller shall be cast iron or bronze construction mounted to a type 303 stainless steel shaft with mechanical seals. Pump bodies shall have integral supporting feet. All pump trim shall be stainless steel for long service life.
- C. Pump motors shall be either an oil filled or hermetically sealed air filled, class F insulation, 1750 RPM, with built-in auto reset thermal/overload protection. Oil filled motors shall have built-in probe to detect oil leaking through the pump seal(s). Pump electric cords shall be 600V UL approved for underwater operation with waterproof compression fitting at motor connection.
- D. Pump shall have oil sensing pump control switch the sump pump will plug into. The switch shall start the pump upon sensing water and stop the pump upon sensing oil.
- E. High alarm controller shall be in an NEMA 4 enclosure complete with alarm horn, alarm light and test buttons. The high alarm shall have one (1) dry contact to be monitored remotely.
- F. Pumps shall be Liberty Pumps ELV Series, Stancor, Weil, Zoeller, or approved equivalent.

2.7 SIMPLEX SUMP PUMP – SUBMERSIBLE

- A. Furnish and install where shown on the plans a sump pump complete with pump, basin, float switches, and pump controller.
- B. Pump shall be non-clog centrifugal, submersible, vertical sump pump. Pump shall be high quality gray cast iron ASTM A-48, class 30 construction. Impeller shall be cast iron or bronze construction mounted to a type 303 stainless steel shaft with mechanical seals. Pump bodies shall have integral supporting feet. All pump trim shall be stainless steel for long service life.
- C. Pump motors shall be either an oil filled or hermetically sealed air filled, class F insulation, 1750 RPM, with built-in auto reset thermal/overload protection. Oil filled motors shall have built-in probe to detect oil leaking through the pump seal(s). Pump electric cords shall be 600V UL approved for underwater operation with waterproof compression fitting at motor connection.
- D. Pump shall have two (2) mercury floats or micro switches, the first for pump on, the second for high alarm. The critical high alarm shall have two (2) dry contacts to be monitored remotely.
- E. Pump basin shall be round fiberglass or HDPE with top bolted flange.
- F. Cover shall be round, flanged to match the basin, made of aluminum or galvanized steel. Cover shall have pump cover plate with power cord hole, inspection cover plate, level control plate, vent flange, within the top. Cover plates shall each be bolted to the top.
- G. Simplex controller shall be in an NEMA 1 enclosure complete fused disconnect switch, control transformer, run lights and test buttons.

- H. Pump capacity, electrical characteristics, and basin dimensions shall be as scheduled on the drawings.
- I. Pumps and controllers shall be Liberty Pumps, Hydromatic, Stancor, Weil, Zoeller, or approved equivalent.

2.8 WATER SOFTENER

- A. Furnish and install an automatic water softening, having the capacity, flow rate and operational requirements as hereinafter specified. The equipment shall be installed according to the manufacturer's recommendations and the Manufacturer's Representative shall place the equipment in service and instruct the Owner's personnel in its care, maintenance and operation. The Contractor shall be responsible for the satisfactory performance of the equipment in accordance with the guarantees required.
- B. The mineral tank shall be constructed of galvanized steel having an operating pressure of 100 psig, tested at 150 psig. The tank shall be fabricated and tested in accordance with the ASME Boiler and Pressure Vessel Code. The mineral tank shall have a diameter of 24" and a side sheet height of [__"]. Structural legs welded to the bottom dome shall support the tank.
- C. The mineral tank shall have two openings: One opening 4" x 6" in the dome for loading and one 4" x 6" opening in the side sheet for inspection of the underdrain system and filling and leveling of the gravel. The mineral tank shall be equipped with a top dome splash PVC distributor with an opening equal to or larger than the unit pipe size. The underdrain system shall be of a non-corrosive slotted design. The slots shall be .012"-.016" wide to retain mineral and the total slot area shall be equal to or larger than the unit pipe size. The underdrain system shall be vented to facilitate complete brine removal. The mineral tank shall contain 150 pounds of #20 flint gravel to cover the underdrain system. The mineral tank shall contain 6.67 cubic feet of mineral, of the sulfonic acid type in the sodium form, which will produce at least 19 kilograins per cubic foot when regenerated with 0.25 pounds of salt per kilograin of hardness removed.
- D. The brine system shall be of the Accumatic high grid plate design. Brine tanks 24" diameter shall be of polyethylene, including cover. Larger diameter tanks shall be of fiberglass, including cover. the system shall include a float operated brine valve constructed of non-corrosive material to control refill, shut-off and refill flow rate. the brine valve shall provide a method of adjusting salt dosage. Brine volume is to be repeatedly accurate within 10% and not dependent on salt bed void space for brine volume. Brine tank shall have sufficient storage to provide a minimum of four (4) regenerations at the maximum salt dosage between refills.
- E. The main control valve shall be of the Taskmaster II motor driven, plunger operated type controlled by a time clock to actuate the cycles of backwash, brine, slow rinse, fast rinse and return to service. The control valve shall not depend on water pressure for positioning and/or actuation. Regeneration shall be initiated by a time clock. A signal is sent from a seven-day time clock, which is field adjustable, when a factory-preset time is reached. Manual regeneration shall also be initiated by advancing the timer knob per operating instructions.
- F. Control valves shall also be equipped with pressure gauges and test sample cocks.
- G. Furnish with equipment a titration-type soft water test kit, equal to Hach Model SB.

- H. A complete set of instructions, including installation, loading start-up, adjustment, servicing and a parts list shall be provided with the equipment. Attrition loss of mineral shall be guaranteed to not to exceed 3% per year for a period of three (3) years. All mechanical equipment shall be guaranteed for one year from data of installation or 18 months from data of manufacturer (whichever comes first) against any defects in workmanship or materials. Any part proving defective will be replaced or repaired within this period.
- I. Softening system shall have a minimum capacity of [] grains when regenerated with a maximum salt dosage of 36 pounds, and a maximum capacity of [] grains when regenerated with a maximum dosage of 100 pounds of salt.
- J. Softening system shall be as manufactured by Culligan, Marlo, Water King, or approved equal.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete housekeeping pad, unless installation on stand, bracket, or suspended platform is indicated.
- B. Maintain manufacturer's recommended clearances.
- C. Arrange units so controls and devices that require servicing are accessible.
- D. Arrange piping for easy removal of water heaters.
- E. Anchor domestic-water heaters to substrate.
- F. Install gas-fired, domestic-water heaters in accordance with NFPA 54.
 - 1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
 - 2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
 - 3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
- G. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- H. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend domestic-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- I. Install commercial domestic-water heaters with seismic-restraint devices where scheduled.

3.2 DOMESTIC WATER INLINE CIRCULATOR INSTALLATION

- A. Mount pumps in orientation complying with manufacturer's written instructions.
- B. Install hanger rods, and vibration isolation were specified, near the pump of the size required to support pump weight.
- C. Check piping connections for tightness.
- D. Clean strainers on suction piping.
- E. Prime pump by opening suction valves and closing drains, and prepare pump for operation.

3.3 DOMESTIC WATER BOOSTER PUMP

- A. Booster-Pump Mounting:
 - 1. Install booster pumps on cast-in-place concrete equipment bases.
 - 2. Support connected domestic-water piping so weight of piping is not supported by booster pumps.

3.4 SUMP PUMP INSTALLATION

- A. Pump Installation Standards: Comply with ANSI/HI 1.4 for installation of sump pumps.

3.5 WATER SOFTENER INSTALLATION

- A. Install water softeners on cast-in-place concrete equipment base(s).
- B. Install brine lines and fittings furnished by equipment manufacturer, but not specified to be factory installed.
- C. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance.
- E. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank.
- F. Install valved bypass in water piping around water softeners.

3.6 FIELD QUALITY CONTROL

- A. Complete installation and startup checks according to manufacturer's written instructions.
- B. Perform tests and inspections[with the assistance of a factory-authorized service representative].
- C. Testing:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Domestic-water heaters, pumps, [water softeners], and associated controls, will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.7 WATER SOFTENER STARTUP SERVICE

- A. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:
1. ASTM D859, "Test Method for Silica in Water."
 2. ASTM D1067, "Test Methods for Acidity or Alkalinity of Water."
 3. ASTM D1068, "Test Methods for Iron in Water."
 4. ASTM D1126, "Test Method for Hardness in Water."
 5. ASTM D1129, "Terminology Relating to Water."
 6. ASTM D3370, "Practices for Sampling Water from Closed Conduits."

3.8 WATER SOFTENER MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [three] [six] [nine] 12 months' full maintenance by skilled employees of water softener Installer. Include [monthly] [quarterly] preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper water softener operation at rated capacity. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.9 DEMONSTRATION

- A. [Engage a factory-authorized service representative to train] Train Owner's maintenance personnel to adjust, operate, and maintain domestic-water heaters, circulators, pumps, [and water softeners]. Training shall be a minimum of [one] [two] <other> hours.

END OF SECTION 22 50 00

SECTION 22 80 00 – PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backflow preventer – reduced pressure
2. Combination temperature and pressure relief valves
3. Expansion tank
4. Hose bibb – interior unfinished spaces
5. Hose bibb - interior
6. Ice maker box
7. Outlet drain box
8. Pressure reducing valves
9. Roof hydrant: exterior free standing roof mounted pedestal
10. Roof hydrant: exterior free standing roof mounted
11. Roof hydrant: curb-mounted.
12. Temperature relief valves
13. Thermostatic mixing valves
14. Thermostatic mixing valves (electronic)
15. Thermostatic recirculation balancing valves
16. Trap primer – electric solenoid type
17. Trap primer – mechanical type
18. Trap primer tailpiece
19. Wall hydrant: exterior with box
20. Wall hydrant: interior with box
21. Water hammer arrestors
22. Water meters

B. Related Requirements:

1. Section 22 00 00 PLUMBING WORK

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.

- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

2.2 MANUFACTURERS:

- A. Backflow preventer – reduced pressure
1. Watts model 994/957
 2. MIFAB/BEECO model FRP
 3. Conbraco Apollo RP4A
 4. Zurn Wilkins model 375/375AST (2-1/2" and larger)
 5. Zurn Wilkins model 975XL3 (2" and smaller).
 6. <OR> Watts model LF909, no substitutions allowed.
- B. Combination temperature and pressure relief valves
1. Cash Acme
 2. Kunkle
 3. Spence
 4. Watts
 5. Approved equivalent
- C. Expansion tank
1. Amtrol Therm-X-Trol
 2. Approved equal
- D. Hose bibb – interior unfinished spaces
1. J.R. Smith 5673
 2. MIFAB MHY-9200-NPB
 3. Wade 8605
 4. Woodford 26
 5. Zurn Z1341XL.
- E. Hose bibb – interior
1. [Chicago Faucets model 835-CP for overhead supplies.]
 2. Chicago Faucets model 897-CCP for supplies thru-the-wall.
 3. Zurn Z841M1 for supplies thru-the-wall.
- F. Ice maker box
1. IPS Corporation model SSIB1AB
 2. Acorn

3. MIFAB
 4. Oatey
- G. Outlet drain box
1. Acorn model 8200-1
 2. IPS Corporation Guy Gray model DBSS1DLV.
 3. MIFAB model MI-DIAL-CS.
- H. Pressure reducing valves
1. Watts model LFF115-74
 2. Zurn Wilkins model ZW209BP
 3. Cla-Val model 90-48
 4. MIFAB ACV x.xx HF-PR.
- I. Roof hydrant: exterior free standing roof mounted pedestal
1. MAPA Products model MPH-24FP:24/9.
- J. Roof hydrant: exterior free standing roof mounted
1. J.R. Smith 5906
 2. MIFAB MHY-58
 3. Watts HY-900
 4. Woodford RHY2-MS
 5. Zurn Z1388XL.
- K. Temperature relief valves
1. Spence, 3/4", 2020 TDGQF
 2. Approved equivalent
- L. Thermostatic mixing valves
1. Mixing valves serving tempered water, individual fixtures or small groups of fixtures shall be:
 - a. Acorn MV-17-[[#]],
 - b. Armstrong RADA
 - c. Bradley S59
 - d. Lawler 310
 - e. Leonard 210
 - f. Powers HydroGuard
 - g. Symmons TempControl
 - h. Approved equivalent.
 2. Central mixing station
 - a. Acorn CSMV-[[#]]
 - b. Bradley Navigator
 - c. Lawler model 80X
 - d. Leonard
 - e. Powers LFMM430
 - f. Approved equivalent
- M. Thermostatic mixing valves (electronic)
1. Acorn model ABMV
 2. Armstrong Brain

3. Lawler
 4. Leonard.
- N. Thermostatic recirculation balancing valves
1. Caleffi ThermoSetter model 116-2X0A-001
 2. Jomar TB-130G
 3. Approved equivalent meeting the specifications.
- O. Trap primer – electric solenoid type
1. Trap Primers for 1-4 supplies shall be
 - a. Precision Plumbing Products model MPB-500-115V
 - b. Josam
 - c. J.R. Smith
 - d. MIFAB
 - e. Watts.
 2. Trap Primers for 5 or greater supplies shall be
 - a. Precision Plumbing Products model PST-X
 - b. Josam
 - c. J.R. Smith
 - d. MIFAB
 - e. Watts.
- P. Trap primer – mechanical type
1. Precision Plumbing Products model PR-500
 2. Josam
 3. J.R. Smith
 4. MIFAB
 5. Watts.
- Q. Wall hydrant: exterior with box
1. Josam 71300
 2. J.R. Smith 5519
 3. IFAB MHY-26
 4. Wade W-8700
 5. Watts HY-330
 6. Woodford B65
 7. Zurn Z1300.
- R. Wall hydrant: interior with box
1. J.R. Smith 5509QT-SAP-NB
 2. MIFAB MHY-35
 3. Wade W-8708
 4. Watts HY-330
 5. Woodford B76
 6. Zurn Z1330-XL.
- S. Water hammer arrestors
1. J.R. Smith Hydrotrol models 5005 to 5050
 2. Josam 75000 series, MIFAB WHB
 3. Precision Plumbing Products SBHA

4. Zurn Z1700

T. Water hammer arrestor access doors

1. J.R. Smith 4730-U-NB
2. MIFAB C1460-S-3-6
3. Wade 8303-85-75-VP
4. Zurn ZANB-1460-9-VP
5. Approved equivalent

U. Water meters

1. Totalizing magnetic turbine meter
 - a. Badger Recordall Turbo Series
 - b. Hersey MTX/WTX, Kent T-3000
 - c. Neptune HP Turbine
 - d. Niagara WPX
 - e. Approved equivalent

<OR>

2. Totalizing compound turbine and positive displacement meter:
 - a. Badger Recordall Compound Series
 - b. Kent C-300
 - c. Neptune Tru/Flow
 - d. Approved equivalent.

2.3 BACKFLOW PREVENTER - REDUCED PRESSURE

- A. Furnish and install reduced pressure backflow preventer at water service entrance and at cross connection locations.
- B. Assembly shall include shut off valves, strainer, test cocks, and pressure relief valve with ASME A112.1.2 air-gap fitting located between two positive seating check valves.
 1. Construction shall be all bronze with quarter-turn, full port, resilient seated ball valve shut offs for sizes 2" and smaller.
 2. 2-1/2" and larger shall be bronze, cast-iron, steel or stainless steel body and interior coating according to AWWA C550 or FDA approved epoxy coating with OS&Y resilient seated gate valve shut offs.
- C. Discharge from air gap shall be piped to a floor drain.

2.4 COMBINATION TEMPERATURE AND PRESSURE RELIEF VALVES:

- A. Combination Temperature-and-Pressure Relief Valves:
 1. ANSI Z21.22/CSA 4.4-M.
 2. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating.
 3. Select one relief valve with sensing element that extends into storage tank.

2.5 EXPANSION TANK

- A. Expansion tank shall be a steel hydro-pneumatic tank rated for a working pressure of 125 psig at 200°F.
 - 1. All internal wetted parts shall comply with FDA regulations and approvals.
 - 2. Capacity shall be as scheduled on the plans.
- B. Installation:
 - 1. Floor mounted tanks shall be installed on a 3-1/2" concrete housekeeping pad, refer to Section 20 00 00.
 - 2. Support and anchoring of tanks is delegated design by the Contractor. Design operating weight shall be based on tank full of water.
 - 3. Prior to opening the expansion tank to the system, the tanks shall be field charged by the Contractor and witnessed by the Engineer. Refer to expansion tank schedule and flow diagrams for charge pressure, if not indicated confirm with the Engineer.

2.6 HOSE BIBB (HB-A): INTERIOR UN-FINISHED SPACES (COLD WATER ONLY)

- A. 3/4" hose outlet x copper sweat inlet with integral vacuum breaker.

2.7 HOSE BIBB (HB-B): INTERIOR (COLD AND HOT WATER)

- A. 6" centers, vacuum breaker rigid spout with 3/4" hose thread outlet, polished chrome finish, wall brace and pail hook, 1/2" F union inlets on exposed valves, lever handles, indexed and tabbed for "HOT" and "COLD".

2.8 ICE MAKER BOX (IMB)

- A. Furnish and install stainless steel wall mounted ice maker shut-off valve box
- B. Provide with 1/4 turn ball valve.
- C. Provide bronze body dual check backflow preventer at ice maker box for connection to equipment, equivalent to Watts Series 7.

2.9 OUTLET BOX: DRAIN (OB-A)

- A. Furnish and install stainless steel wall mounted drain box with hinged door. Box shall have an opening approximately 8" wide x 6" high, and have a 2" drain connection.

2.10 PRESSURE REDUCING VALVES

- A. 3" and larger: automatic, pressure piloted, flanged cast iron body with interior coating according to AWWA C550, bronze or stainless steel trim, low flow bypass pressure control, pressure gauge connections, position indicator, and means for discharge pressure adjustment.

- B. 2-1/2" and smaller: automatic, internal diaphragm sensing, lead free bronze body, stainless steel seat, sealed spring cage, integral pressure by-pass, , cleanable stainless steel strainer. Watts model LFN223B/LFU5B-Z3, Cla-Val CRD-L or Zurn Wilkins model 500XL3/600XL.
- 2.11 ROOF HYDRANT: EXTERIOR FREE STANDING ROOF MOUNTED PEDESTAL (RH-A)
- A. 3/4" hose outlet x 3/4" (nominal) copper sweat straight inlet, non-freeze, drain down design with stainless steel reservoir, fully insulated with stainless steel shroud, approved ASSE 1019 integral backflow preventer.
- B. Installation – Contractor to install in accordance with manufacturer's instructions. Provide service valve on inlet to allow isolation for service, provide support below the roof to anchor the unit to the building structure.
- 2.12 ROOF HYDRANT: EXTERIOR FREE STANDING ROOF MOUNTED (RH-B)
- A. Free standing roof hydrant with 3/4" hose connection outlet with integral backflow preventer x 1" copper sweat inlet and 1/8" NPT drain hole. J.R. Smith 5906, MIFAB MHY-58, Watts HY-900, Woodford RHY2-MS or Zurn Z1388XL.
- <OR
- 2.13 ROOF HYDRANT: CURB MOUNTED (RH-C)
- A. Provide a 24" tall roof curb with 4" insulated sheet metal cap. In the sidewall of the curb install a WH-1 wall hydrant. Provide bracing of the wall hydrant and piping internal to the curb.
- 2.14 TEMPERATURE RELIEF VALVES:
- A. Temperature relief valves on domestic hot water system shall be a self-contained, reverse acting, with adjustable setpoint.
- 2.15 THERMOSTATIC MIXING VALVES
- A. Furnish and install thermostatic tempering valves with integral check valves, removable cartridge strainers, stainless steel pistons, and thermal bellows – rough bronze finish. Valve shall be compliant with ASSE Standard 1017 and CSA B125. Thermostatic mixing valves in emergency fixture applications shall be compliant with ASSE 1071.
- <FOR CENTRAL MIXING STATION WITH HOT WATER CIRCULATION>
- B. A central thermostatic mixing station shall be used to temper domestic hot water supply to the building. (The total load for the building is [#] gpm). System shall consist of a thermostatic mixing valve designed specifically to be installed as the primary control valve within a pumped recirculation system.

2.16 THERMOSTATIC MIXING VALVES (ELECTRONIC)

- A. A central thermostatic mixing station shall be used to temper domestic hot water supply to the building. System shall consist of a thermostatic mixing valve designed specifically to be installed as the primary control valve within a pumped recirculation system. Valve shall be compliant with ASSE Standard 1017 and CSA B125.
- B. Furnish and install shut off valves, check valves, thermometers and accessories per the flow diagram and the manufacturer's installation instructions.

2.17 THERMOSTATIC RECIRCULATION BALANCING VALVE

- A. End of run domestic hot water lines shall be connected to the recirculation line with thermostatic recirculation valve. Valve shall be self-contained and fully automatic without additional piping or control mechanisms. Valve body and all internal components shall be constructed of stainless steel with major components constructed of type 303 stainless steel. Valve shall be NSF-61 certified with zero lead content for use in all domestic water systems. Temperature range shall be field adjustable. Valve shall incorporate a second element for 160°F high temperature bypass for thermal disinfection. Valve shall include inlet and outlet full port ball valves isolation valves to allow cartridge maintenance.
- B. Sizes shall be indicated on the plans.
- C. Factory set temperature to 115°F.
- D. Operations
 - 1. Valve shall regulate the flow of recirculated domestic hot water based on water temperature entering valve regardless of system operating pressure.
 - 2. When fully closed valve shall bypass a minimum flow to maintain dynamic control of the recirculating loop and prevent pump deadheading.
 - 3. Valve shall be field adjustable from 105F to 140F as required by project conditions.
 - 4. At temperatures between 160-170°F second element will open for thermal disinfection.
 - 5. Valve shall modulate between open and closed position within a 10F (5.5C) range.
 - 6. Thermal actuator shall be spring operated and self cleaning, delivering closing thrust sufficient to keep orifice opening free of scale deposits.

2.18 TRAP PRIMER, ELECTRIC SOLENOID TYPE

- A. Trap primers shall be electric solenoid operated, lead free wetted parts, bronze body, air gap or vacuum breaker, with NEMA 1 cabinet. Where serving more than one drain, furnish with distribution unit with 1/2" compression connections.

2.19 TRAP PRIMER, MECHANICAL TYPE

- A. Trap primers shall be piston operated, lead free wetted parts, bronze body, Where serving more than one drain, furnish with distribution unit.

2.20 WALL HYDRANT: EXTERIOR WITH BOX (WH-A)

- A. 3/4" hose outlet x 3/4" (nominal) copper sweat straight inlet, non-freeze, anti-siphon wall hydrant with bronze casing, approved ASSE 1019 integral vacuum breaker and polished nickel bronze, stainless steel, or chrome-plated box.

2.21 WALL HYDRANT: INTERIOR WITH BOX (WH-B)

- A. 3/4" hose outlet x 3/4" (nominal) copper sweat straight inlet, anti-siphon wall hydrant with bronze casing, integral backflow preventer and polished nickel bronze or chrome plated box.

2.22 WATER HAMMER ARRESTOR

- A. Furnish and install all stainless steel shock absorbers at all solenoid, remote operated or quick closing valves such as restroom devices for each battery of fixtures. Install on both domestic hot and cold water branch lines in an upright position. Install where shown on the drawings and as required by code, provide access door when not accessible. Sized according to manufacturer's recommended sizing.
- B. Access door when not accessible shall be 8" x 8" square access covers with polished nickel bronze beveled edge frame with anchor lugs for over the wall installation, smooth stainless steel cover, and vandal proof fasteners.

2.23 WATER METERS

- A. Water meter 1 1/4" through 10" shall be a totalizing magnetic turbine meter indicating in U.S. Gallons meeting AWWA Standard C-701 latest edition. Meters shall be in-line horizontal-axis type per AWWA Class II, flanged cast bronze body, [permanently roll-sealed register], turbine measuring chamber, stainless steel spindle, and graphite bearings. [Meters shall be furnished with pulse transmitters for remote monitoring]. .

<OR >

- B. Water meters 2" through 8" shall be totalizing compound turbine and positive displacement meter indicating in U.S. Gallons. Meters shall be in-line, cast bronze body, [permanently roll-sealed register] with both nutating disk and turbine measuring chamber. [Meters shall be furnished with pulse transmitter for remote monitoring].

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

- A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.

2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- B. Water Regulators: Install with inlet and outlet shutoff valves[and bypass with memory-stop balancing valve]. Install pressure gauges on inlet and outlet.
- C. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.
- D. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.
- E. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.
- F. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow. Install in accordance with manufacturer's instructions. Provide service valve on inlet to allow isolation for service, provide union to allow removal, provide 1/2" copper pipe or tubing from the primer unit to the floor drain or standpipe p-trap being primed.
- G. Drainage-Type, Trap-Seal Primer Device: Install as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.2 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.
- D. Adjust each [pressure vacuum breaker] [reduced-pressure-principle backflow preventer] [double-check, backflow-prevention assembly] [and] [double-check, detector-assembly backflow preventer] <Insert type> in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections[with the assistance of a factory-authorized service representative].
- B. Test each [pressure vacuum breaker] [reduced-pressure-principle backflow preventer] [double-check, backflow-prevention assembly] [and] [double-check, detector-assembly backflow preventer] <Insert type> according to authorities having jurisdiction and the device's reference standard.

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 22 80 00

SECTION 23 00 00 – HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provisions and conditions cited in this Section shall apply to Work for other sections of Divisions 23 of these Specifications.
 - 1. Section 23 21 00 – Hydronic Piping and Equipment
 - 2. Section 23 21 20 – Hydronic Pumps
 - 3. Section 23 22 00 – Steam and Condensate Piping and Equipment
 - 4. Section 23 23 00 – Refrigerant Piping
 - 5. Section 23 25 00 – HVAC Water Treatment
 - 6. Section 23 51 00 – Breechings, Chimneys, and Stacks
 - 7. Section 23 57 00 – Heat Exchangers
 - 8. Section 23 73 00 – Central Station Air Handling Units
 - 9. Section 23 74 00 – Packaged HVAC Equipment
 - 10. Section 23 81 00 – Unitary HVAC Equipment
 - 11. Section 23 82 00 – Convection Heating and Cooling Units
 - 12. Section 23 83 00 – Radiant Heating and Cooling
- C. The following sections of the Specifications apply to Work under this Section
 - 1. Division 20 - Basic Mechanical Conditions and Basic Mechanical Material and Methods
 - 2. Division 25 - Temperature Control
 - 3. Division 26 – Electrical

1.2 SUMMARY

- A. Section Includes: **List**

1.3 QUALITY ASSURANCE

- A. Work for this Section of the Specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Division 20.
- B. Specific requirements for materials shall be as listed in Division 20 Basic Materials and Methods.
- C. Manufacturer's mill reports and applicable documents to certify the validity of the procured piping materials shall be on file at the Contractor's office.
- D. Install all piping with pitch to vent or drain. Provide drain valves at low points and air vents at high points. Drain valves and air vents shall be ¾" bronze 2 piece body ball valves with ¾" hose

end adapter, cap and chain. In ½” through 2” pipe, contractor may use Webstone model T-drain. Use eccentric reducing fittings (installed top level) as required to avoid air pockets.

- E. Gaskets and packings containing asbestos are not acceptable.
- F. Where Pipe and accessories installed under this section of the specification tie-in to existing systems, Contractor shall verify existing for: sizes, direction of flow (via pressure or physical tracing of piping, not labels), materials, and elevations before installing new work. Contractor shall notify Architect/Engineer upon discovery of discrepancy. Work performed prior to verification will be corrected at no cost to Owner.

1.4 ACTION SUBMITTALS

- A. Contractor shall submit coordination drawings to the Engineer for review prior to any fabrication or installation. (Refer to Section 20 10 50).
- B. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- C. Provide manufacturer's technical product data of each material and accessory item with engineering support information, installation manual, operation and maintenance manual. Data shall be specific to product specified and clearly identified on all data sheets, which contains multiple models or sizes.
- D. At the point where the mechanical system has been installed and checked by the Contractor and the systems are ready for testing and adjusting, submit a letter to the Architect/Engineer stating such. Refer to Section 20 10 85.
- E. At the completion of the project, submit a letter stating all materials are asbestos free, and meet the specified ASTM E-84 flame/smoke rating of 25/50, and that all piping and duct penetrations are smoke or fire stopped as required by the Code.

1.5 CLOSEOUT SUBMITTALS

- A. Refer to General Conditions and Division 20.
- B. As-built drawings of underground piping or equipment shall include dimensions from building walls/columns and elevations.
- C. At the completion of the project, submit a letter stating all materials are asbestos free, and meet the specified ASTM E-84 flame/smoke rating of 25/50, and that all piping and duct penetrations are smoke or fire stopped as required by the Code.

1.6 EXISTING CONDITIONS

- A. Where lines installed under this section of the specification tie-in to existing lines Contractor shall verify all existing lines, elevations, and directions of flow before running any new lines.

- B. Contractor shall notify Architect/Engineer upon discovery if the new line cannot tie-in to the existing line due to location, elevation, size, or direction of flow.
- C. Prior to excavation, best efforts shall be made to locate lines with cameras, locating sondes, ground penetrating radar, etc.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 00 00

SECTION 23 21 00 – HYDRONIC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cooling system including piping, piping specialties, pumps, chemical water treatment system, chemical pot feeder, relief valves, air separator, and expansion tank.]
2. Installing of all chiller and refrigeration related specialties including, but not limited to, refrigerant monitor, self-contained breathing apparatus, refrigerant pump out unit and storage vessel.
3. Heating system including, but not limited to, factory assembled/field assembled packaged heat exchanger, piping, chemical pot feeder, piping specialties, pumps, condensate pumps, unit heaters, convectors, terminal heating coils, steam pressure reducing stations, relief valves, chemical pot feeder, air separator and expansion tank.
4. Air handling equipment including, but not limited to, central station air handling units, rooftop air handling units, terminal units, return fans, exhaust fans, coils, and condensing units.
5. Make-up water connections including, but not limited to, piping, backflow preventers, pressure regulators, water meters, and electronic level sensors.
6. Condensing units/remote air-cooled condenser systems including, but not limited to, refrigerant piping, filter-drier, sight glasses, service valves, test-charge ports and accessories.
7. Chemical water treatment of chilled water, heating water, condenser water.
8. Draining, filling, and venting of all modified systems as required for the above work. This includes scheduling shutdowns with the Owner (Refer to Section 20 10 70).
9. All seismic restraints for the above work (Refer to Section 20 10 40).
10. Smoke stopping of all penetrations of pipes and ductwork, and firestopping of the same through fire rated partitions as shown on the Architectural drawings including, but not limited to stairways, shafts, corridors, floors, roofs, and required exits (Refer to Section 20 10 20).]
11. Cleaning and pressure testing equipment, piping, and accessories installed under this section of the specification. (Refer to Section 20 10 50).
12. Leak testing and charging of field piped refrigerant systems (Refer to Section 20 10 50).
13. Provide sufficient labor and resources required for the testing and balancing (Refer to Section 20 10 80) and for the commissioning process (Refer to Section 152300).
14. Installing accessories specified under other sections of the specification referenced in Sub-section 23 00 05, including but not limited to, flow meters, control valves, thermowells, and taps for pressure sensors.

1.2 ACTION SUBMITTALS

- A. Product Data: The Contractor shall submit the following for approval in accordance with Subsection 20 00 43, Duties of the Contractor - Submittals.

1. Piping materials, valves, and accessories as specified in Piping Materials Schedule(s) in this section of the specification.
2. All specialties including, but not limited to, thermometers, gauges, relief valves, pressure regulators, backflow preventers, flow switches, and vacuum breakers.
3. All general items specified under Division 20 utilized in the installation of work required by this section of the specification.

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MISCELLANEOUS PIPING REQUIREMENTS

- A. Itemization of the piping materials for specific system application are enumerated in the following sub-sections for the respective PIPING MATERIAL SCHEDULE. Specific requirements for materials shall be as listed in Division 20 10 00 Basic Materials and Methods.
- B. Manufacturer's mill reports and applicable documents to certify the validity of the procured piping materials shall be on file at the Contractor's office.
- C. Install all piping with pitch to vent or drain. Provide drain valves at low points and air vents at high points. Drain valves and air vents shall be ¾" bronze 2 piece body ball valves with ¾" hose end adapter, cap and chain. In ½" through 2" pipe, contractor may use Webstone model T-drain. Use eccentric reducing fittings (installed top level) as required to avoid air pockets.
- D. Gaskets and packings containing asbestos are not acceptable.
- E. Where Pipe and accessories installed under this section of the specification tie-in to existing systems, Contractor shall verify existing for: sizes, direction of flow (via pressure or physical tracing of piping, not labels), materials, and elevations before installing new work. Contractor

shall notify Architect/Engineer upon discovery of discrepancy. Work performed prior to verification will be corrected at no cost to Owner.

2.3 HYDRONIC SPECIALTIES

A. AIR SEPARATOR

1. Air separators shall be designed, constructed, and stamped for 125 psig at 350°F in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code. Centrifugal type air separator shall have tangential or bottom outlet, tangential inlet, stainless steel collector tube without strainer. Coalescing type air separator shall have internal copper coalescing medium. Air separator shall have flanged inlet and outlet with a threaded drain connection.
2. Air separator shall be Bell & Gossett Rolairtrol, Amtrol, Taco, Armstrong VA, Thrush, Spirovent model HV or equivalent.

B. AUTOMATIC AIR VENT

1. Automatic air vents shall be high capacity, float actuated, cast iron or cast brass body, stainless steel/brass trim and rated for 150 psi at 250°F.
2. Automatic air vents shall have their discharges piped to a drain.
3. Automatic air vents shall be Amtrol Model 720, Armstrong AAE-750, Bell & Gossett 107A, Spirotherm model Spirotop, Thrush model 720 or equivalent.

C. SAFETY VALVES, RELIEF VALVES, SAFETY RELIEF VALVES

1. Valves shall be factory set and field verified for 125 psi, bronze body, stainless steel trim and test/lift lever. Pressure relief valves shall be a minimum of ¾" Bell and Gossett Model 790, Watts 174A, Kunkle or equivalent.
2. Valves shall be ASME Code Section VIII rated, bronze body and brass trim. Safety relief valves shall be Kunkle, Bell and Gossett, Watts or equivalent.

D. PUMP FLOWLINE FITTING (SUCTION DIFFUSER)

1. Fitting shall be 90° angle cast iron body with exit vane, 304 stainless steel strainer with ¼" openings, fine mesh start-up strainer, adjustable support foot, and drain connection.
2. Fitting for [end suction pumps] shall be Bell & Gossett, Armstrong, Taco or equivalent.
3. Fitting for [double suction pumps] shall be Flow Conditioning Corporation or equivalent.

E. MAKE-UP WATER CONNECTION

1. Backflow preventer shall be of reduced pressure type. Assembly shall include shut off valves, strainer and air gap connection. Backflow preventer shall be Watts Series 909 or equivalent.
2. Pressure reducing valves shall be Watts U5, Bell and Gossett #7, Taco 335, Armstrong HRD70 or equivalent.
3. Meters shall be Neptune T-10, Kent C-700, or Hersey MTX 123, or equivalent.
4. Meters shall be in-line horizontal-axis type per AWWA Class II, flanged cast bronze body, permanently roll-sealed register, turbine measuring chamber, stainless steel spindle, and graphite bearings. Meters shall be furnished with pulse transmitters for remote monitoring. Meters shall be Neptune HP Turbine, Kent T-3000, Hersey MTX/WTX, or equivalent.

F. THERMOMETERS

1. Thermometers shall be organic spirit filled in a 9" polyester or aluminum case, magnified lens, glass or acrylic front, black divisions and numbers. Accuracy shall be \pm one scale division. Stem shall be tapered aluminum installed in a brass thermowell.
2. The submittal data shall clearly identify the range and the service the thermometers are used for.
3. Thermometers shall be Weksler AS5, Terice model Adjustable Angle, Weiss Vari-angle, MILJOCO 935, or equivalent.

G. TEST PORTS

1. Test ports shall be pressure and temperature test plugs. Plugs shall be self-sealing plugs. EPDM/Nordel seals rated for the temperature, pressure and fluid associated with the application and shall be capable of accepting a needle type temperature or pressure probe and reclosing when the probe is removed. Acceptable manufacturers and models are as follows:

<u>Manufacturer</u>	<u>Model</u>
Peterson Engineering	Pete's Plug
Terice	Pressure / Temperature Test Plug
Sisco	P/T Plugs
Bell and Gossett	Read-Out Valve RV-125A

2. Alternatively, access fittings may be provided in place of the Pete's Plugs. In this case, the fittings shall be provided with a retained cap and shall be Mueller Brass A-17130 or equivalent.

H. GAUGES

1. Gauges shall be 4-1/2" diameter, flangeless aluminum/stainless steel safety case with removable ring, bottom connection, with a recalibrator, and have stainless steel tube and stainless steel movement calibrated to 1/2% accuracy, ANSI B40.1 Grade 2A with a pressure range appropriate for each system.
2. Gauges shall be Weiss Instruments UG2, Terice 500XSS Series, Weksler AA44Y or equivalent by Marsh, or Marshalltown. Accessories from the same manufacturer shall be acceptable.

2.4 EXPANSION TANKS

- A. Furnish, install, and charge expansion tanks as indicated on the plans, flow diagrams, and schedules. The tanks shall be field charged by the Contractor to provide 10 psig at the high point of the system with all pumps not operating for positive venting.
- B. Expansion tanks shall be constructed in accordance with Section VIII, Division 1, of the ASME Boiler and Pressure Vessel Code and stamped for a minimum working pressure of 125 psi [150 psi, 250 psi] at 200°F. The tanks shall have a standard schrader charging valve (.302" – 32) connection for on-site adjustment of the system pressure. The tanks shall be provided with mounting hardware for either vertical base mount or saddles for horizontal mounting in the configuration shown or scheduled on the drawings.

- C. Diaphragm type tanks shall have a non-replaceable heavy duty butyl rubber diaphragm to separate the air charge and the system water. The minimum system connection size shall be ½” NPT.
- D. Diaphragm type expansion tanks shall be Amtrol AX Series, Bell and Gossett Series D, Taco CAX series, Thrush AX series or approved equivalent.
- E. Bladder type tanks shall have replaceable bladder constructed of heavy duty butyl rubber. The water shall be in bladder, and the air shall be in the tank. The minimum system connection size shall be 1” NPT. The tank shall have a ¾” NPT drain to allow draining water from the tank in the event of a bladder failure. The tank shall have both vertical and horizontal lifting rings.
- F. Bladder type expansion tanks shall be Amtrol L series, Bell and Gossett Series B, Taco CA series, Thrush L series or approved equivalent.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. PIPING MATERIAL SCHEDULE M-1

- 1. Service
 - a. Chilled water supply and return for HVAC. (Unless specified otherwise)
 - b. Hot water (heating) supply and return for HVAC.
- 2. Design Rating:
 - a. 125 PSIG at 350°F
 - b. 175 PSIG at 150°F

3. Pipe (Refer to Section 20 10 11):

SIZE	MATERIAL	THICKNESS
3” and Smaller	Copper	Type L
2½ ” and Smaller (Contractor Option)	Black Carbon Steel ASTM-A53, ERW	Schedule 40
3” to 10”	Black Carbon Steel ASTM-A53, ERW	Schedule 40
12” and Larger	Black Carbon Steel ASTM-A53, ERW	Standard (0.375” wall thickness)

- a. Contractor may use either copper or black carbon steel for piping 3” and smaller. Fittings shall be as noted herein.

4. Fittings (Refer to Section 20 10 12):

SIZE	MATERIAL	Joining Method
3” and Smaller	Wrought Copper	Solder Ends
2½ ” and Smaller (Contractor Option)	Cast Iron	Screwed
3” to 10”	Black Carbon Steel	Buttwelded
12” and Larger	Black Carbon Steel	Buttwelded

- a. Copper piping notes:

- 1) All solder connections shall use 95/5 solder.
- b. Carbon steel notes:
 - 1) Elbows shall be long radius.
 - 2) See Division 20 for acceptable branch arrangement in lieu of tee fitting.
 - 3) Wall thickness of the fittings shall be consistent with the connecting piping.
- c. Grooved connections may be used at vertical branch drops to equipment located within mechanical rooms. Grooved fittings shall be painted ductile iron, smooth (segmented or welded fittings are not acceptable), and with grooved ends. Wall thickness consistent with connecting pipe. To be used in conjunction with compatible rigid mechanical couplings designed specifically for this application.
- d. All piping concealed in chases or walls or above inaccessible ceilings shall be welded.

5. Fittings (Refer to Section 20 10 12):

SIZE	MATERIAL	Joining Method
3" and Smaller	Wrought Copper	Solder Ends
2½ " and Smaller (Contractor Option)	Cast Iron	Screwed
3" to 10"	Black Carbon Steel	Buttwelded
12" and Larger	Black Carbon Steel	Buttwelded

- a. Copper piping notes:
 - 1) All solder connections shall use 95/5 solder.
- b. Carbon steel notes:
 - 1) Elbows shall be long radius.
 - 2) See Division 20 for acceptable branch arrangement in lieu of tee fitting.
 - 3) Wall thickness of the fittings shall be consistent with the connecting piping.
- c. All fittings must be soldered or welded. Mechanical joining methods are not allowed except as otherwise noted.

6. Fittings (Refer to Section 20 10 12):

SIZE	MATERIAL	Joining Method
3" and Smaller	Wrought Copper	Solder Ends
2½ " and Smaller (Contractor Option)	Cast Iron	Screwed
3" to 10"	Black Carbon Steel	Grooved
12" and Larger	Black Carbon Steel	Grooved

- a. Copper piping notes:
 - 1) All solder connections shall use 95/5 solder.
- b. Carbon steel notes:
 - 1) Elbows shall be long radius.
 - 2) See Division 20 for acceptable branch arrangement in lieu of tee fitting.
 - 3) Wall thickness of the fittings shall be consistent with the connecting piping.
- c. Grooved Fittings: Painted ductile iron, smooth (segmented or welded fittings are not acceptable), grooved ends. Wall thickness consistent with connecting pipe. To be used in conjunction with compatible rigid mechanical couplings designed specifically for this application.
- d. All piping concealed in chases or walls or above inaccessible ceilings shall be welded.

7. Valves (Refer to Section 20 10 13):

SERVICE	SIZE	MATERIAL/CONSTRUCTION	TYPE
Shut-off	3" and Smaller	[Two, Three] Piece, Full Port Bronze Body Stainless steel ball and trim	Ball
Shut-off	2½" and Larger	[Cast iron, Ductile iron] body	Butterfly
Balancing / Throttling	12" and Smaller		Multi-Turn Calibrated Balance Valve.
Balancing / Throttling	14" and Larger		Butterfly Valve with Memory Stops
Check Valve (General Duty)	All	Class 125	Swing Check
Check Valve (Pump Discharge)	2½" and Smaller	Class 125	Swing Check
Check Valve (Pump Discharge)	3" and Larger	Class 125 Cast iron body	Silent check

8. Strainers (Refer to Section 20 10 14)

SIZE	MATERIAL/CONSTRUCTION	TYPE
4" and Smaller	Class 125, Cast Iron	Y-Pattern
5" and Larger	Class 125, Cast Iron	Basket Type

9. Flanges:

SIZE	MATERIAL/CONSTRUCTION	PIPING / FITTING TYPE
4" and Smaller	Class 125 ASME standard or Class 150, Cast Copper companion type, soldered end	Copper / Soldered
2½" and Larger	Class 150, Black forged carbon steel, weld neck pattern	Black Carbon Steel / Welded
2½" and Larger	ANSI Class 150, Victaulic 45	Black Carbon Steel / Grooved

10. Unions

- a. 3" and smaller Wrought copper, solder ends

11. Vibration Isolation at Pumps Without Inertia Bases:

- a. Provide and install two (2) Victaulic style 177 couplings (or approved equal) at each pump inlet and outlet connection.

12. Vibration Isolation:

- a. Refer to individual equipment sections for required vibration isolation accessories.

13. Pressure Test (Refer to Section 20 xx xx):

- a. Hydrostatic test at 200 PSIG for two (2) hours minimum

B. PIPING MATERIAL SCHEDULE M-2

- Service: Underground Chilled Water
- Design Rating: 150 PSIG at 60°F

3. Material Specifications (Refer to Section 20 xx xx):

COMPONENT	MATERIAL
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COMPONENT	MATERIAL
Pipe	High Density Polyethylene 4710
Pipe Wall Thickness	SDR-11
Fittings	Fabricated or Molded High Density Polyethylene 4710
Transition at Building Entry	Transitions from indoors to outdoors will be with HDPE to stainless steel transition piece similar to Poly-cam model 815. The underground stainless steel will be protected with a 17# magnesium anode with a cathodic test station at grade.
Joints	Butt Fusion
Valves	Iron body gate valve, flanged, non-rising stem, indicator post pattern, 175 psig, with curb box.
Trace Wire	#12 copper wire

4. Pressure Test (Refer to Section 20 xx xx):
 - a. Hydrostatic test at 200 PSIG for two (2) hours minimum

C. PIPING MATERIAL SCHEDULE M-3

1. Service: Underground Chilled or Heating Hot Water
2. Design Rating: 125 PSIG at 225°F
3. Material Specifications (Refer to Section 20 xx xx):

COMPONENT	MATERIAL
Pipe	Manufactured Pre-Insulated Piping System
Carrier Pipe Material	
Insulation Material	
Jacket Material	
Fitting Material	
Trace Wire	#12 copper wire

4. Pressure Test (Refer to Section 20 xx xx):
 - a. Hydrostatic test at 200 PSIG for two (2) hours minimum

D. PIPING MATERIAL SCHEDULE M-4

1. Service: Non-Potable Make-up water for hydronic systems
2. Design Rating: 175 PSIG at 150°F
3. Material Specifications (Refer to Section 20 xx xx):

COMPONENT	MATERIAL
Pipe	Copper
Pipe Wall Thickness	Type L
Fittings	Wrought Copper
Joining Method	Solder Ends

COMPONENT	MATERIAL
Service Valves	Two piece Ball Valve, Bronze Body, Stainless steel ball and trim

4. Pressure Test (Refer to Section 20 xx xx):
 - a. Hydrostatic test at 200 PSIG for two (2) hours minimum

E. PIPING MATERIAL SCHEDULE M-5

1. Service: Condenser Water Systems

2. Design Rating: 175 PSIG at 150°F

3. Material Specifications (Refer to Section 20 xx xx):

COMPONENT	MATERIAL
Pipe	Fiberglass, lined (A.O. Smith Red Thread)
Fittings	Fiberglass, cement bonded

4. Valves (Refer to Section 20 10 13):

SERVICE	SIZE	MATERIAL/CONSTRUCTION	TYPE
Shut-off	3" and Smaller	[Two, Three] Piece, Full Port Bronze Body Stainless steel ball and trim	Ball
Shut-off	2½" and Larger	[Cast iron, Ductile iron] body	Butterfly
Balancing / Throttling	All		Butterfly Valve with Memory Stops
Check Valve (General Duty)	All	Class 125	Swing Check
Check Valve (Pump Discharge)	2½" and Smaller	Class 125	Swing Check
Check Valve (Pump Discharge)	3" and Larger	Class 125 Cast iron body	Silent check

5. Strainers (Refer to Section 20 10 14)

SIZE	MATERIAL/CONSTRUCTION	TYPE
4" and Smaller	Class 125, Cast Iron	Y-Pattern
5" and Larger	Class 125, Cast Iron	Basket Type

6. Pressure Test (Refer to Section 20 xx xx):
 - a. Hydrostatic test at 200 PSIG for two (2) hours minimum

F. PIPING MATERIAL SCHEDULE M-6

1. Service: Condensate Drain Piping
2. Design Rating: Atmospheric
3. Material Specifications (Refer to Section 20 xx xx):

COMPONENT	MATERIAL
Pipe	Copper
Pipe Wall Thickness	Type L

COMPONENT	MATERIAL
Fittings	Wrought Copper
Joining Method	Solder Ends
[Service Valves]	[Two piece Ball Valve, Bronze Body, Stainless steel ball and trim]

- a. 90° elbows are not permitted, use (2) 45° elbows or 'Y' provided with cap in unconnected straight run.
 - b. Extend piping from all cooling coil drain pans to the location of discharging indirectly to the building drain system. Pipe size shall be unit connection size unless indicated larger on the plans.
 - c. Connections to the drain pans shall be made through a water seal trap with the downstream side vented to atmosphere.
4. Pressure Test (Refer to Section 20 xx xx):
 - a. Pressure test at not less than 15 feet static head of water for two (2) hours minimum.

G. PIPING MATERIAL SCHEDULE M-7

1. Service: Underground Chilled Water, Above Ground or Underground Condenser Water (Un-insulated)
2. Design Rating: 150 PSIG at 210°F maximum working temperature
3. Material Specifications (Refer to Section 20 xx xx):

COMPONENT	MATERIAL
Pipe	Fiberglass reinforced pipe, Red Thread HP16 (uninsulated)
Fittings	Epoxy fittings

- a. Fittings shall be fiberglass reinforced as required for capability with piping; matched tapering and joining.
 - b. Provide retainer glands where flanged ductile iron pipe is installed at point of building entry.
4. Pressure Test (Refer to Section 20 xx xx):
 - a. Hydrostatic test at 150 PSIG for two (2) hours minimum

3.2 INSTALLATION

- A. Install all piping with pitch to vent or drain. Provide drain valves at low points and air vents at high points. Drain valves and air vents shall be ¾" bronze 2 piece body ball valves with ¾" hose end adapter, cap and chain. In ½" through 2" pipe, contractor may use Webstone model T-drain. Use eccentric reducing fittings (installed top level) as required to avoid air pockets.
- B. Gaskets and packings containing asbestos are not acceptable.
- C. Where Pipe and accessories installed under this section of the specification tie-in to existing systems, Contractor shall verify existing for: sizes, direction of flow (via pressure or physical tracing of piping, not labels), materials, and elevations before installing new work. Contractor shall notify Architect/Engineer upon discovery of discrepancy. Work performed prior to verification will be corrected at no cost to Owner.

D. Hydronic Specialties

1. Air Separators
 - a. Furnish and install centrifugal type or coalescing type air separator where shown on the plans or flow diagrams.
2. Automatic Air Vent
 - a. Automatic air vents shall be furnished and installed for all centrifugal air separators.
3. Safety Valves, Relief Valves, Safety Relief Valves
 - a. Pressure relief valves shall be furnished and installed for all [chillers, "free cooling" heat exchangers, etc.] and where shown on the plans, flow diagram, or details in all hydronic systems not containing boilers.
 - b. Hydronic systems containing [heat exchangers or other unfired heating vessels] shall have safety relief valves sized for the rated output of each device at the pressure rating of the lowest pressure device.
 - c. Discharges from valves shall be piped [to floor drains for water valves and to the outdoors for steam valves].
4. Pump Flowline Fitting (Suction Diffuser)
 - a. Furnish and install a pump flowline fitting with strainer at all inlets to base mounted pumps. Fitting shall be coordinated with pump inlet size and system piping, where largest system size available is smaller than the system piping, provide piping reducer at inlet of flowline fitting.
5. Make-up Water Connection
 - a. At all make-up water locations to hydronic systems provide a line size reduced pressure backflow preventer, pressure reducing valve, water meter, and a pressure relief valve. [In closed system the pressure reducing valve and water meter shall be ¾". In open systems the pressure reducing valve and water meter shall be line size.]
 - b. Pressure reducing valves shall be furnished and installed for each system and field adjusted for each system to provide 10 psi at the highest point in the system with all pumps off for positive venting.
 - c. Water meter 1" and smaller shall be a totalizing positive displacement meter indicating in U.S. Gallons meeting AWWA Standard C-700 latest edition.
 - d. Water meter 1 ¼" and larger shall be a totalizing magnetic turbine meter indicating in U.S. Gallons meeting AWWA Standard C-701 latest edition
6. Thermometers
 - a. Thermometer wells and thermometers shall be provided at the inlet and outlet of all [air handling unit coils, chillers, etc.] and where shown on the plans, piping isometrics, flow diagrams and details.
 - b. Stem length and lagging length shall be coordinated with the piping and the insulation. A minimum 2" insertion length shall be in the moving fluid.
 - c. Thermometers for use in [chilled water] having 1°F increments are preferred with a minimum range of 30°F - 100°F, in no case shall the range be greater than 0°F - 160°F having 2°F increments.
 - d. Thermometers for use in [heating water] systems shall have 2°F increments with a range of 30-240°F.
 - e. Where thermometer wells are installed below 5 feet they shall be installed on the side of vertical piping or on the top of horizontal piping so that they can be angled back beyond vertical to allow easy reading. Where thermometer wells are installed above 6 feet they can be installed on the face or the side of vertical piping and for

horizontal piping it should be installed between 9 and 12 o'clock to allow the thermometers to be angled less than vertical without the pipe blocking the view of the thermometer.

- f. Prior to installing the thermometer wells, the contractor shall have the thermometers at the jobsite and shall demonstrate to the Architect/Engineer where they intends to install them where they will be easy to read. If the Contractor fails to perform the above, any thermometers which are unreadable, in the opinion of the Architect/Engineer, it shall be modified at the Contractor's expense.
7. Test Ports
 - a. Provide pressure and temperature test plugs at locations shown on the plans, flow diagrams and details.
 - b. Furnish extensions for test ports installed in insulated piping. Plugs shall be provided with threaded protective caps. One temperature and pressure test kit suitable for the plugs used on the job shall be provided to the Owner on all installations where the plugs are used.
8. Gauges
 - a. Provide 1/4" ball valves gauge cocks at all inlet and outlet of air handling units and across control valves of air handling units and at the inlet and outlets of [chillers, boilers, heat exchangers, pumps, etc.] and where shown on piping isometrics, flow diagrams and details. Provide gauges where shown on piping isometrics, flow diagrams, and details.
 - b. Open water condenser systems shall have compound gauges.
 - c. Gauges located at pumps shall be provided with a porous stone/metal type pressure snubber.
 - 1) Utilizing factory taps in the casing or other locations where steel pipe is utilized, provide 1/4" brass screwed pipe and 1/4" 2-piece bronze threaded ball valve with lever handle for a gauge cock.
 - d. At locations where copper pipe is utilized, provide a 1/2" tee by line size connection in the piping and a 1/2" 2-piece bronze threaded ball valve, and 1/4" NPT bushing with lever handle for a gauge cock.
 - e. Gauges shall be installed as follows: 3" straight piping/nipple, service valve/gauge cock, tee with P/T plug in the run of the tee, and the gauge installed on the branch of the tee. There shall be no change in direction between the valve and the process pipe to allow cleaning an obstruction. The 3" is to create a dead leg to minimize sweating without insulating the valve.
 - f. All gauges shall be positioned where their view is unobstructed and can be easily read. If any gauge is unreadable, in the opinion of the Architect/Engineer, it shall be modified at the Contractor's expense.
- E. Expansion Tanks
 1. Furnish, install, and charge expansion tanks as indicated on the plans, flow diagrams, and schedules. The tanks shall be field charged by the Contractor to provide 10 psig at the high point of the system with all pumps not operating for positive venting.
 2. Diaphragm tanks shall meet or exceed both the minimum acceptance volume and total volume as scheduled. Diaphragm type tanks shall only be used when scheduled as such, otherwise expansion tanks shall be bladder type tanks.
 3. Bladder tanks shall meet or exceed the total volume as scheduled.

3.3 CLEANING AND PROTECTION

A. Clean

END OF SECTION 23 21 00

SECTION 23 21 20 – HYDRONIC PUMPS AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Close-coupled, in-line centrifugal pumps.
 - 2. Close-coupled, end-suction centrifugal pumps.
 - 3. Separately coupled, horizontally mounted, in-line centrifugal pumps.
 - 4. Separately coupled, vertically mounted, in-line centrifugal pumps.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Pumps described herein and indicated on the drawings are based on the manufacture and model number listed under each sub-section. Where pumps are from manufacturers not scheduled the following criteria shall apply: Pumps shall be picked at scheduled flow and head with working fluid of the system which the pump is in, pump impeller shall not be within ½” of the smallest or largest size for the pump body, pump efficiency shall not more than 5% less efficient than scheduled pump, operation point shall not exceed nameplate horsepower, pump motor size shall not be larger than scheduled motor (Contractor can pursue equipment substitution as required in

Subsection 20 00 51 for pumps with larger motors), pumps which are used in parallel installations shall be sized such that the brake horsepower does not exceed the motor horsepower when only one pump is running. This operating point shall not be off of the manufacturers published pump curve.

- B. Cartridge type circulators
 - 1. Bell and Gossett Fox series
 - 2. Armstrong Astro series
 - 3. Grundfos series UP
 - 4. Taco "00" series
 - 5. Approved equivalent
- C. Circulators
 - 1. Bell and Gossett Booster pump,
 - 2. Armstrong series S & H
 - 3. Taco Red Baron Circulator
 - 4. Approved equivalent
- D. Horizontal Inline
 - 1. Bell and Gossett series 60
 - 2. Armstrong series 1060
 - 3. Taco 1600 series
 - 4. Approved equivalent
- E. Inline
 - 1. Bell and Gossett series 80
 - 2. Armstrong 4380/4300 series
 - 3. Taco KS model
 - 4. Approved equivalent
- F. Base-mounted End Suction
 - 1. Bell and Gossett Series 1510
 - 2. Armstrong Series 4030
 - 3. Peerless Type F
 - 4. Taco Model FI
 - 5. Approved equivalent
- G. Automatic Condensate Pump Units
 - 1. Little Giant
 - 2. Aspen
 - 3. Blue Diamond
 - 4. Diversitech
 - 5. Rectorseal
 - 6. Sauermann
- H. Suction Diffuser
 - 1. Armstrong
 - 2. Bell and Gossett
 - 3. Grundfos
 - 4. Taco

2.3 GENERAL

- A. Furnish and install circulating pumps for water service of the base mounted or in-line configuration as scheduled on the drawings. Pumps shall be factory tested, aligned, painted, and shipped complete for installation. Electrical characteristics shall be as scheduled on the plans.

2.4 IN-LINE PUMPS

- A. General: In-line pumps and circulators shall be suitable for mounting in either vertical or horizontal piping with the motor mounted as specified below. Pumps shall be flanged and provided with a companion flange having NPT tappings or shall be ANSI Standard B16.1 flanges. Pumps shall have factory taps, shipped with plugs installed, for measuring suction and discharge pressure, and at the low point in the volute to allow draining.
- B. Cartridge type circulators shall be bronze or iron construction as scheduled. Pumps shall be maintenance free, horizontal (motor and shaft installed position) in-line, single stage, wet rotor type with the motor mounted directly to the pump volute rated for 125 psi, 230°F operation. The integral motor shall be cooled and lubricated by the pump fluid. The motor stator shall be isolated from the circulated fluid through use of a stainless steel rotor can. The pump shaft shall be ceramic supported by ceramic/carbon bearings.
- C. Circulators shall be bronze or iron construction as scheduled. Pumps shall be horizontal (motor and shaft installed position) in-line, oil lubricated, one-piece dynamically balanced impeller, and flexible coupling. Pumps shall be rated for 125 psi at 225°F. Mechanical seals shall be two piece with a carbon seal face and ceramic seat rated for continuous operation at 225°F. Motors shall be open drip-proof type with sleeve bearings, quiet operating, rubber mounted, with built-in thermal overloads.
- D. Horizontal in-line pumps shall be bronze or iron construction as scheduled. Pumps shall be horizontal (motor and shaft installed position) in-line type, oil lubricated, one-piece cast bronze impeller dynamically balanced, and flexible coupled. Pumps shall be rated for a maximum working pressure of 175 psi at 150°F and 150 psi at 250°F. Mechanical seals shall be two piece design with a carbon seal face and ceramic seat rated for continuous operation at 225°F. Pump shall be of a three-piece design consisting of: the volute, bearing module, and the motor; with each section bolted to the next. The bearing module shall have oil lubricated bronze journal and thrust bearings. The motor shall be joined to the pump shaft through a flexible coupling. Motors shall be NEMA B letter design with a 1.15 service factor, open drip-proof, premium efficiency.
- E. In-line pumps shall be bronze fitted Class 30 cast iron body designed for either horizontal or vertical (motor and shaft installed position) in-line mounting, oil lubricated, one piece cast bronze dynamically balanced impeller, replaceable bronze wear rings, steel pump shaft with replaceable bronze shaft sleeve, close/split coupled. Pumps shall be rated for a maximum working pressure of 175 psi at 150°F and 150 psi at 250°F (125# ANSI flange) [or 250 psi at 90°F and 200 psi at 150°F (250# ANSI flange)]. Mechanical seals shall be flushed two piece design with a carbon seal face and ceramic seat rated for continuous operation at 225°F. Motors shall be NEMA JM, with a 1.15 service factor regreaseable ball bearings, vertical shaft, drip-proof enclosure, premium efficiency.

2.5 BASE MOUNTED END SUCTION PUMPS

- A. End suction base mounted circulating pumps shall be Class 30 cast iron [ductile iron] case construction allowing rear removal of bearing assembly and impeller without disturbing piping or motor alignment, dynamically balanced cast bronze impeller, replaceable bronze wear rings, mechanical shaft seal, heavy duty bearings for long service life on oversized steel shaft with replaceable bronze shaft sleeve connected to motor through a shielded flexible coupling designed to absorb minor misalignment and vibrations. Pumps shall be rated for a maximum working pressure of 175 psi at 150°F and 150 psi at 250°F (125# ANSI flange) [or 250 psi at 90°F and 200 psi at 150°F (250# ANSI flange)]. Mechanical seals shall be flushed two piece design with a carbon seal face and ceramic seat rated for continuous operation at 225°F. Motors shall be NEMA B design letter with a 1.15 service factor, open drip-proof, premium efficiency. Pumps shall have factory taps shipped with plugs installed for suction pressure, discharge pressure, and at the low point in the volute to allow draining. .

2.6 AUTOMATIC CONDENSATE PUMP UNITS

- A. Packaged units with corrosion-resistant pump, [aluminum] [plastic] tank with cover, and automatic controls. Collects and removes condensate from fan coil units, air handling units, condensing boilers, and similar components. Include factory- or field-installed check valve and 72-inch-minimum, electrical power cord with plug, or wiring kit for installation in mini-split drain pan.

2.7 SUCTION DIFFUSER

1. Angle pattern.
2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
3. Bronze 16-mesh wire startup and Type 304 stainless steel permanent strainers with 3/16-inch perforations and 51 percent open area.
4. Type 304 stainless steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations [and inertia bases] for suitable conditions where pumps will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Piping at pumps shall be arranged to facilitate pump maintenance. Piping shall be arranged so that the service valves can be closed and the piping and specialties between the service valves and pump removed for servicing and to allow clear access to the pump for removal as required. Where pump connection sizes are smaller than the line sizes associated with the suction and discharge piping, concentric reducers or increasers shall be installed immediately at the pump flanges to adapt to the indicated line size. All specialties and service valves associated with the pump such as strainers, check valves, etc., shall be line size, and not pump connection size.
- B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- C. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.
- D. Inline Pumps
 - 1. General: Where in-line pumps are installed in horizontal or vertical piping, the pump shall be rigidly mounted to the piping with pipe hangers on each side of pump, but the motor shall not be supported. Where in-line pumps are supported from the floor using a pipe stand/column then two flexible mechanical couplings shall be used on each side of the pump for vibration isolation.
- E. Equipment Mounting:
 - 1. Unit shall be installed on 3-1/2" concrete pad. Refer to Section 20 00 00 BASIC MECHANICAL CONDITIONS.
 - 2. After installation of the base mounted pumps and anchoring the base in place, the Contractor shall follow manufacturer's instructions for filling the steel bases with grouting cement. Pump bases which are to be grouted shall be grouted prior to the final alignment.
 - 3. Refer to flow diagram and details for piping specialties for the pumps.
 - 4. Following the completion of all piping connections, pump couplings and drives shall be systematically aligned using approved methods and instruments. Before putting the pumps into service, the alignment shall be approved by the Architect/Engineer.
 - 5. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
 - 6. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
 - 7. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and [elastomeric hangers] [spring hangers] [spring hangers with vertical-limit stop] of size required to support weight of in-line pumps.
 - a. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 CLEANING AND PROTECTION

- A. Clean

3.4 STARTUP

- A. [Where existing systems are modified, provide start-up strainers at all existing pumps. Strainers shall be removed after 72 hours of operation.]

END OF SECTION 23 21 20

SECTION 23 22 00 – STEAM AND CONDENSATE PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Steam specialties
 - 2. Steam condensate duplex pump
 - 3. Steam condensate duplex pump – elevated tank
 - 4. Steam piping
- B. Furnish and install

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Itemization of the piping materials for specific system application are enumerated in the following sub-sections for the respective PIPING MATERIAL SCHEDULE. Specific requirements for materials shall be as listed in Division 20 10 00 Basic Materials and Methods.
- C. Manufacturer's mill reports and applicable documents to certify the validity of the procured piping materials shall be on file at the Contractor's office.

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 MANUFACTURERS

2.3 MISCELLANEOUS PIPING REQUIREMENTS

- A. Gaskets and packings containing asbestos are not acceptable.

2.4 STEAM SPECIALTIES

- A. Vacuum Breaker (Steam Heat Exchangers and Steam Coils):
1. Furnish and install at all heat exchangers and entering side of steam coils a vacuum breaker rated for a maximum working pressure of 150 psig and 366°F operating temperature.
 2. Vacuum breakers shall be Bell and Gossett No. 26, or approved equal.
- B. Pressure Regulators:
1. Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff. Valves shall have cast-iron body, hardened stainless-steel trim, replaceable head and seat, main head stem guide fitted with flushing and pressure-arresting device, cover over pilot diaphragm, and non-asbestos gaskets.
 2. [Main valve – Spence E, cast iron body, 2-1/2” and larger [125] [250] lb. flanges, 2” and smaller 250 lb. threaded.]
 3. [Pressure regulator - Spence D5, 5-25 psig range.]
 4. See schedule for sizes, capacities, and operating pressures.
- C. Temperature Regulators:
1. Pilot-actuated, diaphragm type, with adjustable temperature range and positive shutoff. Valves shall have cast-iron body, hardened stainless-steel trim, replaceable head and seat, main head stem guide fitted with flushing and pressure-arresting device, cover over pilot diaphragm, and non-asbestos gaskets.
 2. [Main valve – Spence E2, cast iron body, 2-1/2” and larger 125 lb. flanges, 2” and smaller 250 lb. threaded.]
 3. [Temperature regulator – Spence T134, style 704 bronze temperature bulb and temperature well, 70°F – 170°F range, 10 ft. brass flexible tubing.]
 4. See schedule for sizes, capacities, and operating pressures.
- D. Float and Thermostatic Traps (Modulation Loads):
1. Float and Thermostatic Traps: ASTM A126, cast-iron body and bolted cap; renewable, stainless steel float mechanism with renewable, hardened stainless-steel head and seat; maximum allowable pressure of [125, 200] psig; balanced-pressure, stainless-steel or monel thermostatic bellow element. Thermostatic air vent capable of withstanding 45°F of superheat and resisting water hammer without sustaining damage.
 2. Steam traps shall be Armstrong, Hoffman, Spirax Sarco, or Watson McDaniel.

3. See schedule for sizes, capacities, and operating pressures.

E. Steam Traps [WU Only]

1. Drip traps or traps for constant loads for low and high pressure steam systems shall be fixed orifice type. The flow of condensate through the trap shall be controlled by a removable and interchangeable orifice module. Access to the orifice module shall be accomplished without removing the trap from the system piping. Trap shall be equipped with an integral wire mesh strainer located at the trap inlet and a separate Y-type strainer with stainless steel screen attached to the inlet connection of the trap. Trap body, orifice module and integral strainer shall be fabricated from stainless steel.
2. Trap manufacturer shall size the trap and associated orifice. Trap manufacturer shall also verify that the trap is installed in complete accordance with the manufacturer's requirements and shall assume final responsibility for the proper performance of the trap installation.
3. Load traps for applications with modulating steam control valves shall be Modular Duo-Dynamic Float Steam Trap.
4. Steam Traps shall be Tech-Fitt, no substitutions. Local representative is Mike Stam, Steam Management Systems, 314-644-5988.
5. Sizes and capacities shall be as scheduled on the drawings.

F. Inverted Bucket Traps: (Drip Legs)

1. Inverted Bucket Traps: ASTM A126, cast iron body and bolted cap; renewable, stainless steel float mechanism with renewable hardened chrome steel valve and seat; maximum allowable pressure of 250 psig.
2. Steam traps shall be Armstrong, Hoffman, Spirax Sarco, or Watson McDaniel.
3. See schedule for sizes, capacities, and operating pressures.

G. Flash Tanks:

1. Shop or factory fabricated of welded steel according to the ASME Boiler and Pressure Vessel Code, for 150-psig (1035-kPA) rating; and bearing ASME label. Fabricate with tapings for vents, low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

H. Blowdown Separator

1. Furnish and install a blowdown separator as shown on the plans. The separator shall be manufactured in accordance with ASME Code for a minimum of 150 psig. The separator shall have internal baffling/ strike plates, 150# ANSI flanged connections, automatic drain aftercooler, remote bulb temperature regulator valve, bi-metal thermometer, and floor stand.

2.5 STEAM CONDENSATE DUPLEX PUMP

- A. Furnish and install where shown on the plans a duplex condensate pump complete with pumps, receiver, float switches, and duplex controller. The entire pump package shall be U.L. labeled and NEMA [1] rated.
- B. Receiver shall be [cast iron] [3/16" stainless steel] with factory threaded connections for inlet, overflow, and vent.

- C. Pumps shall be 2-stage low NSPH centrifugal type rated at 210°F condensate with brass or stainless steel impeller with flow inducer to prevent cavitation, cast iron pump housing, high temperature (250 °F) mechanical seal and stainless steel motor shaft. The entire pump assembly shall be permanently aligned and dynamically balanced to deliver its full rated capacity. The pump shall be driven by an industry standard motor available "off the shelf." The motor shall have a NEMA standard shaft.
- D. The receiver shall be equipped with: (1) inlet strainer, (1) externally adjustable 2-pole mechanical alternator, top and bottom shut-off water level gauge, dial thermometer, (2) pressure gauges for pump discharge, (2) isolation valves between pump and receiver plus a valve in each bleed line installed for maintenance
- E. Duplex controller shall be in an enclosure complete with two (2) fused disconnect switches, (2) combination magnetic starters (each having 3 overload relays) with circuit breakers and cover interlock for lock-out tag-out capability, electric alternator, control power transformer, (2) hand-off-auto selector switches, (2) pilot run lights, (2) momentary contact "Test" push buttons. A float switch assembly to turn on a high water alarm mounted in control panel with bell, light and silencing relay with dry contacts to access the building management system alarm. The unit shall have a single point power connection
- F. Each pump control circuit shall be completely independent of the other. The mechanical alternator shall:
 - 1. Change the operating sequence automatically after each cycle
 - 2. Provide simultaneous operation under peak load conditions
 - 3. Operate the second pump automatically, should the active pump or its control fail.
- G. Pumps shall be manufactured by Shipco Propeller series, Sterlco 4700 "K" series, Armstrong International, or approved equivalent.
- H. WARRANTY:
 - 1. Cast iron receivers shall have a 20-year corrosion warranty.

2.6 STEAM CONDENSATE DUPLEX PUMP - ELEVATED TANK

- A. Furnish and install where shown on the plans a duplex condensate pump complete with pumps, receiver, float switches, and duplex controller. The entire pump package shall be U.L. labeled and NEMA [1] rated.
- B. Elevated receiver shall be [cast iron] [stainless steel] with factory threaded connections for inlet, overflow, and vent.
- C. Pumps shall be 2-stage low NSPH centrifugal type rated at 212°F condensate with brass or stainless steel impeller with flow inducer to prevent cavitation, cast iron pump housing, high temperature (250 °F) mechanical seal and stainless steel motor shaft. The entire pump assembly shall be permanently aligned and dynamically balanced to deliver its full rated capacity. The pump shall be driven by an industry standard motor available "off the shelf." The motor shall have a NEMA standard shaft.

- D. The receiver shall be equipped with: (1) inlet strainer, (1) externally adjustable 2-pole mechanical alternator, top and bottom shut-off water level gauge, dial thermometer, (2) pressure gauges for pump discharge, (2) isolation valves between pump and receiver plus a valve in each bleed line installed for maintenance
- E. Duplex controller shall be in an enclosure complete with two (2) fused disconnect switches, (2) combination magnetic starters (each having 3 overload relays) with circuit breakers and cover interlock for lock-out tag-out capability, electric alternator, control power transformer, (2) hand-off-auto selector switches, (2) pilot run lights, (2) momentary contact "Test" push buttons. A float switch assembly to turn on a high water alarm mounted in control panel with bell, light and silencing relay with dry contacts to access the building management system alarm. The unit shall have a single point power connection
- F. Each pump control circuit shall be completely independent of the other. The mechanical alternator shall:
 - 1. Change the operating sequence automatically after each cycle
 - 2. Provide simultaneous operation under peak load conditions
 - 3. Operate the second pump automatically, should the active pump or its control fail.
- G. Pumps shall be manufactured by Shipco Propeller series, Sterlco 4700 "K" series, Armstrong International, or approved equivalent.
- H. WARRANTY:
 - 1. Cast iron receivers shall have a 20-year corrosion warranty.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing conditions....

3.2 INSTALLATION

- A. Install all piping with pitch to vent or drain. Provide 150 pound ball valves with hose end adapter at all low points and manual key operated air vents at all high points. Use eccentric reducing fittings (installed bottom level) as required to avoid air pockets.
- B. Steam systems shall be defined as: low pressure when operating between 0-15 psig, medium pressure when operating between 16-50 psig, high pressure when operating above 51 psig.
- C. In steam systems service valves and strainers shall be installed with the stem/basket in the horizontal position so that condensate flow is not impeded.
- D. Install pigtail siphon at all pressure gauge and pressure transmitter locations. Refer to Section 23 10 09 for gauge specifications.

3.3 PIPING APPLICATIONS

A. STEAM PIPING MATERIAL SCHEDULE M-1

1. Service
 - a. Steam supply: Low pressure, medium pressure, steam vents, steam relief boiler feed, boiler blowdown, boiler overflow.
2. Design Rating:
 - a. 125 PSIG at 350°F

3. Pipe (Refer to Section 20 10 11):

SIZE	MATERIAL	WALLTHICKNESS
10" and Smaller	Black Carbon Steel ASTM-A53, ERW	Schedule 40
12" and Larger	Black Carbon Steel ASTM-A53, ERW	Standard

4. Fittings (Refer to Section 20 10 12):

SIZE	MATERIAL	JOINING METHOD
2" and Smaller	Cast Iron, 125#	Screwed
2½" to Larger	Black Carbon Steel, standard schedule	Buttwelded

- a. All piping concealed in chases or walls or above inaccessible ceilings shall be welded.

5. Valves (Refer to Section 20 10 13):

SERVICE	SIZE	MATERIAL/CONSTRUCTION	TYPE
Shut-off	2" and Smaller	Class 125, bronze body	Gate Valve
Shut-off	2½" thru 12"	Class 125, iron body	Gate Valve
Balancing / Throttling	2" and Smaller	Class 125, bonze body	Globe Valve
Balancing / Throttling	2½" thru 12"	Class 125, iron body	Globe Valve

6. Strainers (Refer to Section 20 10 14)

SIZE	MATERIAL/CONSTRUCTION	TYPE
4" and Smaller	Class 125, Cast Iron	Y-Pattern
5" and Larger	Class 125, Cast Iron	Basket Type

7. Flanges:

SIZE	MATERIAL/CONSTRUCTION	PIPING / FITTING TYPE
All Sizes	Class 150, Black forged carbon steel, weld neck pattern	Welded

8. Pressure Test (Refer to Section 20 xx xx):
 - a. Hydrostatic test at 200 PSIG for two (2) hours minimum

B. STEAM PIPING MATERIAL SCHEDULE M-2

1. Service
 - a. Steam supply: High pressure
2. Design Rating:

- a. 150 PSIG at 400°F

3. Pipe (Refer to Section 20 10 11):

SIZE	MATERIAL	WALL THICKNESS
10" and Smaller	Black Carbon Steel ASTM-A106, Seamless	Schedule 40
12" and Larger	Black Carbon Steel ASTM-A106, Seamless	Standard

4. Fittings (Refer to Section 20 10 12):

SIZE	MATERIAL	WALL THICKNESS
2" and Smaller	Cast Iron, 250#	Screwed <Rated to 250 psig at 400°F>
[2" and Smaller (Contractor Option)]	[Forged Steel, 2000#]	[Screwed <Rated to 615 psig at 900°F>]
2½" to Larger	Black Carbon Steel, standard schedule	Buttwelded

- a. All piping concealed in chases or walls or above inaccessible ceilings shall be welded.

5. Valves (Refer to Section 20 10 13):

SERVICE	SIZE	MATERIAL/CONSTRUCTION	TYPE
Shut-off	2" and Smaller	Class 300, bronze body <Rated to 300 psig at 550°F>	Gate Valve
Shut-off	2½" and Larger	Class 150, steel body <Rated to 150 psig at 550°F>	Gate Valve

6. Strainers (Refer to Section 20 10 14)

SIZE	MATERIAL/CONSTRUCTION	TYPE
4" and Smaller	Class 250, Cast Iron	Y-Pattern
5" and Larger	Class 250, Cast Iron	Basket Type

7. Flanges:

SIZE	MATERIAL/CONSTRUCTION	PIPING / FITTING TYPE
All Sizes	Class 150, Black forged carbon steel, weld neck pattern <Rated to 150 psig at 500°F>	Welded

8. Pressure Test (Refer to Section 20 xx xx):

- a. Hydrostatic test at 200 PSIG for two (2) hours minimum

C. STEAM PIPING MATERIAL SCHEDULE M-3

1. Service

- a. Steam supply: High pressure

2. Design Rating:

- a. 250 PSIG at 406°F
b. [300 PSIG at 550°F]

3. Pipe (Refer to Section 20 10 11):

SIZE	MATERIAL	WALL THICKNESS
10" and Smaller	Black Carbon Steel ASTM-A106, Seamless	Schedule 40
12" and Larger	Black Carbon Steel ASTM-A106, Seamless	Standard

4. Fittings (Refer to Section 20 10 12):

SIZE	MATERIAL	WALL THICKNESS
2" and Smaller	Cast Iron, 250#	Screwed <Rated to 250 psig at 400°F>
[2" and Smaller (Contractor Option)]	[Forged Steel, 2000#]	[Screwed <Rated to 615 psig at 900°F>]
2½" to Larger	Black Carbon Steel, standard schedule	Buttwelded

- a. All piping concealed in chases or walls or above inaccessible ceilings shall be welded.

5. Valves (Refer to Section 20 10 13):

SERVICE	SIZE	MATERIAL/CONSTRUCTION	TYPE
Shut-off	2" and Smaller	Class 300, bronze body <Rated to 300 psig at 550°F>	Gate Valve
Shut-off	2½" and Larger	Class 300, steel body <Rated to 450 psig at 800°F>	Gate Valve

6. Strainers (Refer to Section 20 10 14)

SIZE	MATERIAL/CONSTRUCTION	TYPE
4" and Smaller	Class 300, Cast Iron	Y-Pattern
5" and Larger	Class 300, Cast Iron	Basket Type

7. Flanges:

SIZE	MATERIAL/CONSTRUCTION	PIPING / FITTING TYPE
All Sizes	Class 150, Black forged carbon steel, weld neck pattern <Rated to 300 psig at 850°F>	Welded

8. Pressure Test (Refer to Section 20 xx xx):

- a. Hydrostatic test at 450 PSIG for two (2) hours minimum

D. STEAM PIPING MATERIAL SCHEDULE M-4

1. Service: Underground Steam

2. Design Rating:

- a. 125 PSIG at 225°F
b. [250 PSIG at 400°F]

3. Material Specifications (Refer to Section 20 xx xx):

COMPONENT	MATERIAL
Pipe	Manufactured Pre-Insulated Piping System for High Temp

COMPONENT	MATERIAL
	Service
Carrier Pipe Material	Black carbon steel schedule 40
Insulation Material	" thick [Mineral Wool] [polyisocyanurate]
Air Space	Air space required with drain and vent plugs.
Jacket Material	[10 ga. steel with epoxy coating]
Fitting Material	Black carbon steel, butt welded

a. [A complete cathodic protection system shall be provided with test station]

4. Pressure Test (Refer to Section 20 xx xx):

a. Hydrostatic test at [200 PSIG] for two (2) hours minimum

E. CONDENSATE RETURN PIPING MATERIAL SCHEDULE

1. Service

a. Condensate return (all types)

2. Design Rating:

a. 125 PSIG at 220°F

3. Pipe (Refer to Section 20 10 11):

SIZE	MATERIAL	WALL THICKNESS
5" and Smaller (Contractors Option)	Copper	Type L
5" and Smaller	Black Carbon Steel ASTM-A53, ERW	Schedule 80
6" and Larger	Black Carbon Steel ASTM-A53, ERW	Standard (0.375" wall thickness)

4. Fittings (Refer to Section 20 10 12):

SIZE	MATERIAL	Joining Method
2½" and Smaller	Extra Heavy Cast Iron, 250#	250# Screwed
[2½" and Smaller]	[Black Carbon Steel, Schedule 80]	[Socket Welded]
3" thru 5"	Black Carbon Steel, Schedule 80	Butt welded
6" and larger	Black Carbon Steel, standard schedule	Butt welded

a. All piping concealed in chases or walls or above inaccessible ceilings shall be welded.

5. Valves (Refer to Section 20 10 13):

SERVICE	SIZE	MATERIAL/CONSTRUCTION	TYPE
Shut-off	2" and Smaller	Class 125, bronze body	Gate Valve
Shut-off	2½" and Larger	Class 125, iron body	Gate Valve
Check Valve	2" and Smaller	Class 125, bronze body	Sing Check

6. Strainers (Refer to Section 20 10 14)

SIZE	MATERIAL/CONSTRUCTION	TYPE
4" and Smaller	Class 125, Cast Iron	Y-Pattern
5" and Larger	Class 125, Cast Iron	Basket Type

7. Flanges:

SIZE	MATERIAL/CONSTRUCTION	PIPING / FITTING TYPE
All Sizes	Class 150, Black forged carbon steel, weld neck pattern	Welded

8. Pressure Test (Refer to Section 20 xx xx):

- a. Hydrostatic test at 150 PSIG for two (2) hours minimum

3.4 INSTALLATION

A. Provide

B. Steam Condensate Duplex Pump

1. Unit shall be installed on 3-1/2" concrete pad. Refer to Section 20 00 00 BASIC MECHANICAL CONDITIONS.
2. Route full size unit drain line to floor drain/sink. Provide with service valve on the unit drain line. Route full size overflow line with 12" trap (overflow loop) to spill over floor drain/sink. Route 1/2" drain line with service valve from condensate main to unit drain line.
3. Route full size unit vent to discharge to outside the building at a safe location per code.
4. Pipe connections to unit shall not be interfere with unit control panel. Contractor to review the manufacturer manual for the exact locations.
5. Refer to flow diagram and details for piping specialties on the discharge of the pumps.

C. Steam Specialties

1. In general, boilers and other fired heating equipment shall have factory furnished, Contractor installed, [safety valves for steam boilers, relief valves for hydronic boilers]. In the event that the valves are not factory furnished the Contractor shall furnish and install ASME Code Section IV [relief valves for hydronic boilers, 15 psig or less steam boilers] and ASME Code Section I safety valve(s) for steam boilers with rated pressures above 15 psig. Discharges from valves shall be piped to the outdoors for steam valves.

3.5 CLEANING AND PROTECTION

A. Clean

END OF SECTION 23 22 00

SECTION 23 23 00 – REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Copper tube and fittings
 - 2. Valves and specialties
 - 3. Refrigerants
- B. Furnish and install

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing conditions....

3.2 INSTALLATION

- A. Provide
- B. Product A
 - 1.
 - 2.
- C. Product B
 - 1.
 - 2.

3.3 CLEANING AND PROTECTION

- A. Clean

END OF SECTION 23 23 00

SECTION 23 25 00 – HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. HVAC water treatment.
 - 2. Manual chemical-feed equipment.
 - 3. Automatic chemical-feed equipment
 - 4. Chemicals.
 - 5. Inhibited ethylene glycol and propylene glycol.
 - 6. HVAC makeup-water softener.
 - 7. RO equipment for HVAC makeup water.
 - 8. Filtration equipment.

1.2 DEFINITIONS

- A. EEPROM: Electrically erasable, programmable read-only memory.
- B. PPM: Parts per million.
- C. RO: Reverse osmosis.
- D. TDS: Total dissolved solids consist of salts and other materials that combine with water as a solution.
- E. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.
- F. LSI: Langelier's Stability Index predicts the tendencies of water

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.

- B. Parts List: For each type of product that has replaceable parts.

1.6 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 SERVICE PROVIDERS

- A. The following companies
1. Chemtron RiverBend
 2. Chemtreat
 3. ChemAqua
 4. American Water Treatment
 5. Nalco
 6. Or approved equivalent

2.2 PERFORMANCE REQUIREMENTS, GENERAL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems as indicated in this Specification. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or to the environment.
- C. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

2.3 PERFORMANCE REQUIREMENTS FOR CLOSED-LOOP HYDRONIC SYSTEMS

- A. Closed hydronic systems, shall maintain the following water qualities:
1. pH: Maintain a value between 9.0 to 11.0.
 2. Conductivity: less than 4000 μ mhos
 3. Nitrate: 300-600 ppm in Chilled water, 500-1000 in heating water
 4. Alkalinity: Maintain a value within <Insert range> mg/L as CaCO₃.
 5. Steel Corrosion Inhibitors: Provide sufficient inhibitors to limit mild steel corrosion to less than 0.1 mils per year. Maintain soluble iron concentrations at or below <Insert value> mg/L.

6. Stainless Steel Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to less than 0.1 mils per year. Maintain soluble copper concentrations at or below <Insert value> mg/L.
7. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to less than 0.1 mils per year. Maintain soluble copper concentrations at or below <Insert value> mg/L.
8. Scale Control: Provide sufficient scale inhibitors to prevent formation of scale and maintain all scale-forming material in solution.
9. Dispersants: Provide sufficient dispersants to prevent sedimentation of fine particulate matter.
10. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maintain a maximum value of 1,000 organisms/mL.
 - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.

2.4 MANUAL CHEMICAL-FEED EQUIPMENT WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

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- A. Bypass Feeders: Feeders shall be cast iron bulk type feeders complete with connections for water in, treated water outlet, drain, isolation and drain valves, and removable covers. Feeders shall be Ball feeder type, rated for continuous operation at 200 psi and 250°F, Dearborn Type AV, J.L. Wingert Co., Neptune VTF or equivalent.
 1. [Chilled Water: 5, 12, 18 gallon feeder]
 2. [Heating Water: 5, 12, 18 gallon feeder]

2.5 CHEMICAL-TREATMENT TEST EQUIPMENT

- A. Corrosion Test-Coupon Assembly: three (3) sample coupon racks shall be installed at the following location(s):
 1. [Chilled Water: PVC rack]
 2. [Heating Water: Steel rack]
- B. Sample Cooler:
 1. Tube: Sample.
 - a. Size: NPS 1/4 tubing.
 - b. Material: ASTM A666, Type 316 stainless steel.
 - c. Pressure Rating: Minimum 2000 psig.
 - d. Temperature Rating: Minimum 850 deg F.
 2. Shell: Cooling water.
 - a. Material: ASTM A666, Type 304 stainless steel.
 - b. Pressure Rating: Minimum 250 psig.
 - c. Temperature Rating: Minimum 450 deg F.
- C. Chemical supplies and services of a qualified Water Treatment Representative shall be provided by the [Contractor] [Owner].
 1. The Water Treatment Representative shall provide chemicals and be present for filling, flushing, and cleaning of piping systems. The systems shall each be filled through a

meter and the system volume recorded and included on the record drawings. Refer to Section 20 10 56 - Cleaning of Piping System.

2. The Water Treatment Representative shall provide chemicals and be present for treatment of closed loop systems. The system shall be tested and coupon samples weighed quarterly for the first year of operation. The chemistry shall be adjust to control corrosion, scale, and biological growth. Submit to Owner and Engineer reports and lab test from each visit.

2.6 AUTOMATIC CHEMICAL-FEED EQUIPMENT WATER TREATMENT FOR STEAM SYSTEMS

2.7 HVAC MAKEUP -WATER FILTRATION EQUIPMENT

2.8 STAINLESS STEEL PIPES AND FITTINGS

- A. Stainless Steel Tubing: Comply with ASTM A269/A269M, Type 316.
- B. Stainless Steel Fittings: Comply with ASTM A815/A815M, Type 316, Grade WP-S.
- C. Two-Piece, Full-Port, Stainless Steel Ball Valves: ASTM A351/A351M, Type 316 stainless steel body; ASTM A276/A276M, Type 316 stainless steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig steam working pressure and 600-psig cold working pressure ratings.

2.9 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.
- B. Chemicals for direct steam injection humidification and for steam used in direct contact with food to be FDA approved and safe for these uses.

2.10 INHIBITED ETHYLENE GLYCOL AND PROPYLENE GLYCOL

- A. Inhibited Ethylene Glycol:
 1. Ethylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon-steel, brass, copper, stainless steel, and cast-iron piping and fittings.
 2. Inhibitor creates a passive layer on all surfaces that contact ethylene glycol to prevent corrosion by stabilizing fluid pH, to compensate for acids formed from glycol degradation.
 3. pH value shall be maintained between <Insert range>, with reserve alkalinity greater than <Insert number> mL.

4. Operating Temperature Range: [Minus 60 deg F to 250 deg F] <Insert range>.
5. Concentrated inhibited ethylene glycol is to be 95.5 percent ethylene glycol by weight and 4.5 percent performance additives.
6. Concentrated inhibited ethylene glycol is mixed with water in proper proportion specified by the manufacturer to provide freeze protection to [minus 20 deg F] <Insert number>. Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at time of installation. Use only deionized water for mixing.
7. Provide only ethylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

B. Inhibited Propylene Glycol:

1. Propylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon-steel, brass, copper, stainless steel, and cast-iron piping and fittings.
2. Inhibitor creates a passive layer on all surfaces that contact propylene glycol to prevent corrosion and stabilizes fluid pH, to compensate for acids formed from glycol degradation.
3. pH value shall be maintained between <Insert range>, with reserve alkalinity greater than <Insert number> mL.
4. Operating Temperature Range: [Minus 50 deg F to 250 deg F] <Insert range>.
5. Concentrated inhibited propylene glycol is to be 95.5 percent propylene glycol by weight and 4.5 percent performance additives.
6. Concentrated inhibited propylene glycol is mixed with water in proper proportion specified by the manufacturer to provide freeze protection to [minus 20 deg F] <Insert number>. Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at the time of installation. Use only deionized water for mixing.
7. Provide only propylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

2.11 HVAC MAKEUP-WATER SOFTENER

- A. Description: Twin mineral tanks and one brine tank, factory mounted on skid.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA70, by a qualified testing agency, and marked for intended location and application.
- C. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event, when tank supports are anchored to building structure as recommended in writing by manufacturer.
- D. Mineral Tanks:
 1. Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 2. Fabricate and label fiber-reinforced plastic filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
 3. Pressure Rating: 150 psig minimum.
 4. Wetted Components: Suitable for water temperatures from 40 to at least 100 deg F.

5. Freeboard: 50 percent minimum, for backwash expansion above the normal resin bed level.
 6. Support Legs or Skirt: Constructed of structural steel, welded or bonded to tank before testing and labeling.
 7. Finish for Steel tanks: Hot-dip galvanized on exterior and interior of tank after fabrication.
 8. Upper Distribution System: Single-point type, fabricated from galvanized-steel pipe and fittings.
 9. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging polyethylene strainers; arranged for even-flow distribution through resin bed.
- E. Controls: Automatic; factory mounted on mineral tanks and factory wired.
1. Adjustable duration of regeneration steps.
 2. Push-button start and complete manual operation override.
 3. Pointer on pilot-control valve shall indicate cycle of operation.
 4. Means of manual operation of pilot-control valve if power fails.
 5. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:
 - a. Slow opening and closing, nonslam operation.
 - b. Diaphragm guiding on full perimeter from fully open to fully closed.
 - c. Isolated dissimilar metals within valve.
 - d. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
 - e. Float-operated brine valve to automatically measure the correct amount of brine to the softener, and refill with fresh water.
 - f. Sampling cocks for soft water.
 6. Flow Control: Automatic control of backwash and flush rates over variations in operating pressures that do not require field adjustments. Equip mineral tanks with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons and that automatically resets after regeneration to preset total in gallons for next service run. Include alternator to regenerate one mineral tank with the other in service.
- F. Brine Tank: Combination measuring and wet-salt storing system.
1. Tank and Cover Material: Fiberglass a minimum of 3/16 inch thick; or molded polyethylene a minimum of 3/8 inch thick.
 2. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
 3. Size: Large enough for at least four regenerations at full salting.
- G. Factory-Installed Accessories:
1. Piping, valves, tubing, and drains.
 2. Sampling cocks.
 3. Main-operating-valve position indicators.

4. Water meters.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

- A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drains.
- B. Install seismic restraints for equipment and floor-mounting accessories, and anchor to building structure. See Section _____ "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Install interconnecting control wiring for chemical-treatment controls and sensors.
- D. Mount sensors and injectors in piping circuits.
- E.

3.3 INSTALLATION OF WATER SOFTENER

- A. Install water softener equipment on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
- B. Install seismic restraints for tanks and floor-mounting accessories, and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Install brine lines and fittings furnished by equipment manufacturer but not factory installed.
- D. Prepare mineral-tank distribution system and underbed for minerals, and place specified mineral into mineral tanks.
- E. Install water-testing sets on wall adjacent to water softeners.

3.4 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Where installing piping adjacent to equipment, allow space for service and maintenance.
- C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section _____ "Hydronic Piping."
- D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section _____ "General-Duty Valves for HVAC Piping."
- E. See Section _____ "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

3.5 ELECTRICAL CONNECTIONS

- A. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.
- B. Ground equipment in accordance with Section _____ "Grounding and Bonding for Electrical Systems."
- C. Connect wiring in accordance with Section _____ "Low-Voltage Electrical Power Conductors and Cables."

3.6 FIELD QUALITY CONTROL

- A. Testing Agency:
 - 1. Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
 - 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 - 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 - 3. Place HVAC water-treatment system into operation, and calibrate controls during the preliminary phase of HVAC system's startup procedures.
 - 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 - 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 - 7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and

allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.

8. Repair leaks and defects with new materials, and retest piping until no leaks exist.
- D. Prepare test and inspection reports.
- E. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report, advising Owner of changes necessary to adhere to "Performance Requirements" Article for each required characteristic. Sample boiler water at [four] [six] [eight] <Insert number>-week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.
- F. At [four] [six] [eight] <Insert number>-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis, advising Owner of changes necessary to adhere to "Performance Requirements" Article.
- G. Comply with ASTM D3370 and with the following standards:
 1. Silica: ASTM D859.
 2. Steam System: ASTM D1066.
 3. Acidity and Alkalinity: ASTM D1067.
 4. Iron: ASTM D1068.
 5. Water Hardness: ASTM D1126.

3.7 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion, scale formation, and biological growth for [cooling, chilled-water piping] [heating, hot-water piping] [heating, steam and condensate piping] [steam and condensate system for humidifier and cooking appliance applications] [condenser-water piping] and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
 1. Initial water analysis and HVAC water-treatment recommendations.
 2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
 3. Periodic field service and consultation.
 4. Customer report charts and log sheets.
 5. Laboratory technical analysis.
 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 23 25 00

SECTION 23 51 00 – BREECHING, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Field-fabricated metal breechings
2. Double-wall non insulated gas vent.
3. Double wall insulated gas vent.
4. Type B, Double-wall
5. Single-wall, AL29-4C
6. Double-wall AL29-4C

B. Furnish and install breeching, chimneys and stacks for fuel-fired equipment.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product.

B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

A. Amerivent

- B. Ampco Stacks
- C. Duravent
- D. Heat-Fab
- E. Metalbestos
- F. Metal-Fab
- G. Schebler
- H. Selkirk
- I. Approved equivalent

2.3 FIELD FABRICATED METAL BREECHINGS

- A. Fabricate breechings from ASTM A1011/A1011M hot-rolled steel with continuously welded joints, complying with NFPA 211 for minimum metal thickness.
- B. Fabricate cleanout doors from compatible material, same thickness as breeching, bolted and gasketed.

2.4 LISTED VENTS GENERAL REQUIREMENTS

- A. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

2.5 DOUBLE WALL - NON-INSULATED

- A. The factory-built chimney and vent connectors shall be laboratory tested and listed under U.L. 103 for use with building heating boilers, engine/turbine, burning gas #2 through #6 oil, as described in NFPA 211, which produce exhausted flue gasses at a temperature not exceeding 1400°F under continuous operating conditions or 1800°F intermittent.
- B. The double wall stack shall have an outer jacket of a minimum of .025" thick aluminum coated steel. There shall be a minimum 1" air gap between the walls. The inner gas carrying pipe shall be a minimum of .035" thick type 316 stainless steel.
- C. Inner pipe joints shall be sealed by use of V Bands and RTV Silicone Sealant for flue gas temperature up to 1400°F.

2.6 DOUBLE WALL – INSULATED

- A. The factory-built chimney and vent connectors shall be laboratory tested and listed under U.L. 103 for use with building heating boilers, engine/turbine, burning gas #2 through #6 oil, as described in NFPA 211, which produce exhausted flue gasses at a temperature not exceeding 1400°F under continuous operating conditions or 1800°F intermittent.
- B. The double wall stack shall have an outer jacket of a minimum of .025" thick aluminum coated steel. There shall be a minimum 1" insulation between the walls. The inner gas carrying pipe shall be a minimum of .035" thick type 316 stainless steel.

2.7 B VENT, DOUBLE WALL

- A. Furnish and install, for Category I gas fired appliances, factory built double wall B vent flue system.
- B. The vent shall be U.L. 441 listed and conform to the requirements of NFPA 54 latest edition. Vents shall terminate as required by code.
- C. The vent shall have an inner wall constructed of a minimum of .018" thick aluminum alloy. The outer wall shall be a minimum of .020" of G-90 galvanized steel.

2.8 SINGLE WALL AL 29-4C

- A. Furnish and install UL listed single wall AL-4C stainless steel flue system for all high efficiency, condensing, gas fired equipment with combustion gas temperatures below 550°F.
- B. Flue shall be suitable for ANSI Category I, II, III, or IV Appliances rated for operating pressures from negative to 3" w.c. positive pressure.

2.9 DOUBLE WALL AL 29-4C

- A. Furnish and install U.L. listed double wall AL-4C stainless steel flue system for all high efficiency, condensing, gas fired equipment with combustion gas temperatures below 550°F.
- B. Flue shall have AL-4C stainless steel inner wall and Type 430 stainless steel outer jacket with an air space separating the two walls.
- C. Flue shall be suitable for ANSI Category I, II, III, or IV Appliances rated for operating pressures from negative to 3" w.c. positive pressure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing conditions prior to installation for access, structure, type of construction. etc., to facilitate installation.

3.2 INSTALLATION

- A. Provide complete venting system including breeching, chimneys and stacks as required for the boiler, water heater, or appliance being vented.
 - 1. The system is to be installed and sealed per manufacturer's instructions so all joints are gas tight preventing leakage of combustion products into the building.
 - 2. Stacks and vents shall terminate as required by code.
 - 3. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
 - 4. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
 - 5. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
 - 6. Lap joints in direction of flow.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.
- C. FIELD FABRICATED METAL BREECHINGS
 - 1. Suspend breechings independent of their appliance connections.
 - 2. Align breechings at connections, with smooth internal surface and a maximum 1/8-inch misalignment tolerance
 - 3. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.
 - 4. Support breechings from building structure with bolts, concrete inserts, steel expansion anchors, welded studs, C clamps, or beam clamps according to manufacturer's written instructions.
- D. DOUBLE WALL - NON-INSULATED
 - 1. Inner pipe joints shall be sealed by use of V Bands and RTV Silicone Sealant for flue gas temperature up to 1400°F.
 - 2. All parts exposed to the outer atmosphere should be protected by a stainless steel outer jacket or a minimum of one base coat and one finish coat of paint, such as Series 4200-4300 Heat Resistance paint manufactured by Rust-O-Leum Corporation, or equivalent
- E. DOUBLE WALL – INSULATED
 - 1. Inner pipe joints shall be sealed by use of V Bands and RTV Silicone Sealant for flue gas temperature up to 1400°F.
 - 2. All parts exposed to the outer atmosphere should be protected by a stainless steel outer jacket or a minimum of one base coat and one finish coat of paint, such as Series 4200-4300 Heat Resistance paint manufactured by Rust-O-Leum Corporation, or equivalent

3.3 CLEANING AND PROTECTION

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.
- B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.
- C. Provide temporary closures at ends of breechings that are not completed or connected to equipment.

END OF SECTION 23 51 00

SECTION 23 57 00 – HEAT EXCHANGERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. SHELL and U-TUBE:
 - 2. SHELL and STRAIGHT TUBE:

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. SHELL and U-TUBE:
 - 1. Armstrong
 - 2. Bell & Gossett
 - 3. Taco
 - 4. Approved equivalent
- B. SHELL and STRAIGHT TUBE:
 - 1. Baltimore AirCoil
 - 2. Approved equivalent

2.3 SHELL and U-TUBE - Building Heating Water

- A. [Water to water] [Steam to water] heat exchanger shall be constructed according to ASME Section VIII, Division 1 and rated for [125], [150], [300] psi, 300°F water [50 psi, 300°F steam] in shell and rated for [125], [150], [300], [400] psi, 300°F water in the tubes.
- B. Materials:
1. Shell: [Steel] [Stainless steel].
 2. Head: [Cast iron] [Cast stainless steel] [Fabricated steel] [Fabricated steel with removable cover] [Fabricated stainless steel] [Fabricated stainless steel with removable cover]. Flanged and bolted to shell.
 3. Tube: [Seamless copper] [Steel] [Cupronickel] [Stainless steel] tubes.
 - a. Tube diameter is determined by manufacturer based on service.
 4. Tubesheet Materials: [Brass] [Steel] [Stainless steel].
 5. Baffles: [Brass] [Steel] [Stainless steel].
- C. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
1. NPS 2 and Smaller: Threaded ends in accordance with ASME B1.20.1.
 2. NPS 2-1/2 and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.
- D. Support Saddles:
1. Fabricated of material similar to shell.
 2. Fabricate foot mount with provision for anchoring to support.

2.4 SHELL and U-TUBE – Double Wall, Domestic Hot Water

- A. [Water to water] [Steam to water] heat exchanger for domestic hot water service shall be rated for 150 psi, 300°F heating water [50 psi, 300°F steam] in the shell and rated for 150 psi, 300°F domestic water in the tubes.
- B. Materials:
1. Shell: [Steel] [Stainless steel].
 2. Head: [Cast brass] [Cast stainless steel] [Fabricated stainless steel] [Fabricated stainless steel with removable cover]. Flanged and bolted to shell.
 3. Tube: [Seamless copper] [Steel] [Cupronickel] [Stainless steel] tubes.
 - a. Tube diameter is determined by manufacturer based on service.
 - b. Space between the tubes vented to atmosphere for positive leak detection
 4. Tubesheet Materials: [Brass] [Steel] [Stainless steel].
 5. Baffles: [Brass] [Steel] [Stainless steel]..
- C. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
1. NPS 2 and Smaller: Threaded ends in accordance with ASME B1.20.1.
 2. NPS 2-1/2 and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

- D. Support Saddles:
 - 1. Fabricated of material similar to shell.
 - 2. Fabricate foot mount with provision for anchoring to support.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing conditions....

3.2 INSTALLATION

- A. Furnish and install heat exchangers as scheduled and shown on drawings.
- B. SHELL-AND-TUBE HEAT EXCHANGER
 - 1. Install heat exchangers on saddle supports.
 - 2. Heat-Exchanger Supports: Mount heat exchanger on steel saddles and supports specifically designed for each heat exchanger.
 - 3. Fabricate attachment of saddle supports to pressure vessel with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger saddles are anchored to building structure.
- C. PIPING CONNECTIONS
 - 1. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 2. Maintain manufacturer's recommended clearances for tube removal, service, and maintenance.
 - 3. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.
 - 4. Install shutoff valves at heat-exchanger inlet and outlet connections.
 - 5. Install pressure-relief valves on heat-exchanger shells where a connection has been provided on shell. When no shell pressure-relief valve connection has been provided, install pressure-relief valve on shell outlet piping before any isolation valves.
 - 6. Install pressure-relief valves on heat-exchanger tube outlet piping before any isolation valves.
 - 7. Pipe pressure-relief valves, full size of valve connection, to floor drain.
 - 8. Install hose end valve to drain shell.
 - 9. Install thermometer on each heat-exchanger fluid[inlet and] outlet piping.
 - 10. Install pressure gauges on each heat-exchanger fluid [inlet and] outlet piping[and steam inlet piping].
 - 11. Install vacuum breaker at heat-exchanger steam inlet connection.

3.3 CLEANING AND PROTECTION

- A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

- B. Isolate heat exchangers from piping before flushing piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blind flanges in flanged joints to isolate equipment.
- C. Flush heat-exchanger piping systems with clean water; then remove and clean or replace strainer screens before reopening flow to heat exchangers.

END OF SECTION 23 57 00

SECTION 23 73 00 – CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modular double wall air handling units
2. Custom double wall air handling units

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D.

2.2 MANUFACTURERS

A. MODULAR DOUBLE WALL AIR HANDLING UNITS

1. Carrier
2. Daikin
3. JCI
4. Trane

B. CUSTOM DOUBLE WALL AIR HANDLING UNITS

1. Air Flow Equipment, Inc
2. Alliance Air Products
3. Energy Labs, Inc.
4. Miller-Picking
5. Temtrol
6. Trane Custom
7. JCI/York Custom

C. INDIRECT GAS-FIRED AIR HANDLING UNITS

1. Aeon
2. Carrier
3. Daikin
4. JCI
5. Trane

2.3 MODULAR DOUBLE WALL AIR HANDLING UNITS

- A. Furnish and install air handling units as specified below, and as described in diagrams and schedules on the drawings. The unit shall include frame casing, insulated drain pans, heating and cooling coils, fan assemblies, access panels for easy access to all service points, bearings, motors and drives and guards.
- B. The units shall be constructed of welded or bolted angle or channel steel frames. The entire frame assembly shall be hot dipped galvanized after fabrication, or suitably treated with a rust inhibitor coating. The casing shall be 2-inch solid double wall G90 galvanized metal with foam injected panels. The casing shall be rated per ASHRAE/ANSI 1350 to meet or exceed the following: L/240 deflection at 8" positive and negative pressures – Class CD2; Class CL6 Leakage at 8" positive and negative pressures; R-13 Class CT1; Thermal bridging Class CB0. Hinged access doors with camlocks and heavy duty hinges shall be provided for ready access to bearings, motors, drives, coils, piping devices and connections, and other points required for maintenance service or inspection. Condensate drain pans shall be installed with 2" of insulation provided between the drain pan and the casing and shall drain both the coil and the fan; units with multiple vertically stacked coils shall have an intermediate drain pan. The pans shall be of continuously welded seams, Series 300 stainless steel construction, 'V' shaped and/or sloping to the drain connection, flat pans will not be acceptable. Drain pans shall be located in the coil section and in the fan section.
- C. Indoor units: Entire air handling unit shall set on base rails to allow deep condensate trap and where shown on the plans extended base rails shall be provided to support external filter housing

- and sheet metal transitions. Base rails shall be a minimum of 6" height where no size is indicated on the plans.
- D. Outdoor units: Roof shall be cross-broken and pitched with "C" caps over joints to provide watertight seal.
- E. Fans shall have capacities and minimum wheel diameters as indicated on the schedules. Each fan shall be of the non- overloading centrifugal type with deep drawn inlet rings, streamlined housing and scroll, with blades continuously welded to the flange, solid backplate, full curved shroud, and flanged discharge collar. Where Class II construction is required, wheels shall be reinforced with a welded intermediate ring. Fan bearings shall be heavy duty, self-aligning, grease lubricated, antifriction type with double row rollers and labyrinth grease seals. Grease fittings shall be extended through the unit housing. Provide drain openings at the bottom of each fan scroll. Each fan shall be equipped with an adjustable pitch V-belt drive selected for 1.5 times the motor horsepower, motor slide-rail base and drip-proof motor. Fans and motors shall be resiliently mounted on a single structural base, internally mounted with resilient mounts on the unit structural frame. Fans shall be airfoil or backward inclined as scheduled. Forward curved fans may be used only where specifically scheduled. Internal resilient mounting shall be spring type with minimum 1-1/2" static deflection and provided with seismic restraints.
- F. Manufacturer shall use the most energy efficient fan option within the manufacturer's line for the unit size but in no case will the wheel be smaller than the diameters scheduled.
- G. The units shall be provided with coils of the types and capacities scheduled. Cooling coil casing shall be Series 300 stainless steel, others shall be galvanized steel. Coils shall be constructed with no less than 1/2" diameter x .020" wall thickness copper tubes and .0075" aluminum or copper fins spaced not closer than 8 per inch. Fins shall be permanently secured to the tubes by mechanical bonding or soldering and shall be plate type. Frame shall be shall include intermediate tube supports to prevent sagging of the tubes. The coil shall be removable with removing casing panels (i.e., casing shall have its own internal frame and shall not use the coil for support).
- H. [Water coil] headers and "U" bends shall be arranged so that the entrained air is carried along with the flow of water through the coil to the high point on the leaving water header. High points in the coil shall be provided with vent connections. Multi-row coils shall be arranged for counterflow heat exchange between the air and water.
- I. [Refrigerant coils] shall be row split or interlaced type with equalizing distributors. Coils shall be tested to 300 psig and shipped with a holding charge of dry nitrogen. Tube diameters, wall thickness, and fins shall be the same as above.
- J. [Steam coils] shall be one pass (opposite and connections) non-freeze distributing tube type with concentric steam supply and condensate return tubes. Inner steam supply tubes shall have orifices for even distribution of steam.
- K. Heat Wheels:
1. Casing:
a. Galvanized steel, stainless steel, or aluminum with manufacturer's standard finish.

- b. Integral purge section limiting carryover of exhaust air to between [0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.5 percent at 400-Pa and 0.20 percent at 1000-Pa)] <Insert values> differential pressure.
 - c. Casing seals on periphery of rotor, on duct divider, and on purge section.
 - d. Support rotor on grease-lubricated ball bearings with extended grease fittings. Mount horizontal wheels on tapered roller bearing.
 2. Rotor, Aluminum or Polymer: Segmented wheel, strengthened with radial spokes[, with nontoxic, noncorrosive, silica-gel desiccant coating].
 3. Rotor - Aluminum, Metallic, or Polymer: Segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, 3-angstrom molecular-sieve desiccant coating.
 4. Drive: Fractional horsepower motor and gear reducer[, with speed changed by variable-frequency controller]. Permanently lubricated wheel bearings with an [L-10] <Insert bearing life> [400,000 hours] <Insert hours>.
 5. Controls:
 - a. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
 - b. [Variable-frequency controller, factory mounted and wired, permitting input of field connected 4- to 20-mA or 1- to 10-V control signal.]
 - c. [Variable-frequency controller, factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.]
 - d. [Variable-frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain [exhaust temperature above freezing and]air differential temperature above set point. Provide maximum rotor speed when exhaust-air temperature is less than outdoor-air temperature.
 6. Pilot-Light Indicator: Display rotor rotation and speed.]
 7. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
 - L. Fixed-Plate Sensible Heat Exchangers:
 1. Casing: [Aluminum] [Galvanized steel] <Insert material>.
 2. Plates: Evenly spaced and sealed and arranged for [counter] [cross] airflow.
 3. Plate Material: [Embossed aluminum] [Stainless steel] [High-density plastic].
 4. Coatings are available for aluminum plates in corrosive atmospheres.
 5. Plate Coating: [Epoxy] <Insert coating>.
 6. Bypass: Plenum within casing, with gasketed face-and-bypass dampers that have operating rods extended outside casing.
 - M. Heat-Exchanger Prefilters: 2 inches thick, disposable, MERV 8.

2.4 CUSTOM DOUBLE WALL AIR HANDLING UNITS

- A. Furnish and install where shown on the plans, mechanical frame style air handling units specifically designed for indoor application with construction features as specified below. The units shall be provided and installed in strict accordance with the specifications. All units shall be complete with all components and accessories as specified. Any exceptions must be clearly defined. The contractor shall be responsible for any additional expenses that may occur due to any exception made.

B. Unit Construction

1. General: Provide factory-fabricated air handling units with capacity as indicated on the schedule. Units shall have overall dimensions as indicated and fit into the space available with adequate clearance for service as determined by the Engineer. Units shall be completely assembled. Multiple sectioned units shall be shipped as a single factory assembled piece (except where shipping limitations prevent) de-mounted into modular sections in the field by the contractor. Units shall be furnished with sufficient gasket and bolts for reassembly in the field by the contractor. Unit manufacturer shall provide certified ratings conforming to the latest edition of AMCA 210, 310, 500 and AHRI 410. All electrical components and assemblies shall comply with NEMA standards. Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems." Units shall comply with NFPA 70, "National Electrical Code," as applicable for installation and electrical connections of ancillary electrical components of air handling units. Tags and decals to aid in service or indicate caution areas shall be provided. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and maintenance manuals shall be furnished with each unit. Units shall be UL or ETL listed.
2. Rigging Provision – Multiple Piece Units: Units shipped in multiple sections shall be engineered for field assembly. The base frame shall have integral lifting lugs. The lifting lugs shall be fabricated from structural steel with an appropriate rigging hole. Lifting lugs shall be located at the corner of each section (and along the sides if required) and sized to allow rigging and handling of the unit. All gasket and necessary assembly hardware shall ship loose with unit. Junction boxes with a factory supplied numbered terminal strip shall be supplied at each shipping split for reconnection of control wiring.
3. Unit Base - Floor: Unit perimeter base rail shall be fabricated using heavy gauge steel. C-Channel cross supports shall be welded to perimeter base steel and located on maximum 24" centers to provide support for internal components. Base rails shall include lifting lugs at the corner of the unit or each section if de-mounted. Internal walk-on floor shall be 16 gauge galvanized steel. The outer sub-floor of the unit shall be made from 20 gauge galvanized steel. The floor cavity shall be spray foam insulated with floor seams gasketed for thermal break and sealed for airtight / watertight construction. Where access is provided to the unit interior, floor openings shall be covered with walk on phenolic coated steel safety grating. Single wall floors with glued and pinned insulation and no sub floor are not acceptable. Base frame shall be attached to the unit at the factory.
4. Unit Casing – The construction of the air handling unit shall consist of a (1" x 2") steel frame with formed 16 gauge exterior casing panels. The exterior casing panels shall be attached to the gasketed (1 x 2) steel frame with corrosion resistant fasteners. All casing panels shall be completely removable from the unit exterior without affecting the unit's structural integrity. (Units without framed type of construction shall be considered, provided the exterior casing panels are made from 20 gauge galvanized steel, maximum panel center lines are less than 20 inches and deflection is less than L/200 @ 8" positive pressure). The air handling unit casing shall be of the "no-through-metal" design. The casing shall incorporate insulating thermal breaks as required so that, when fully assembled, there's no path of continuous unbroken metal to metal conduction from inner to outer surfaces. All panel seams shall be caulked and sealed for an airtight unit.
5. The exterior panel finish shall be painted with a polyester resin coating designed for long term corrosion resistance meeting or exceeding (ASTM B-117) Salt Spray Resistance at

- 95 degrees F. 2,500 hrs. and (ASTM D-2247) Humidity Resistance at 95 degrees F. 2,500 hrs. The color shall be sandstone.
6. Note: If manufacturer cannot provide thermal break (no through metal) and or removable exterior panel construction it must be noted as an exception on the bid.
 7. Double Wall/Roof Liner –
 - a. Each unit shall have double wall construction with 16 gauge solid galvanized liner in the:
 - a) Outdoor Air Section
 - b) Exhaust Air Section, downstream of exhaust fans
 - c) Return Air Section, downstream of return fans
 - d) Supply Air Section, upstream of supply fans
 - e) Heating Water Coil Casing
 - b. 16 gauge solid stainless steel liner in the:
 - a) Chilled Water Coil Casing
 - c. 22 gauge perforated galvanized liner in the:
 - a) Exhaust Air Section, upstream of exhaust fans
 - b) Return Air Section, upstream of return fans
 - c) Supply Air Section, downstream of supply fans
 - d. The double wall interior panel shall be removable from the outside if the unit without affecting the structural integrity of the unit.
 8. Fiberglass Insulation – Perforated liner sections to be insulated with a full 3” thick non-compressed fiberglass insulation. The insulation shall have an effective thermal conductivity (C) of .24 (BTU in. /sq. ft. F°) and a noise reduction coefficient (NRC) of 0.70 / per inch thick (based on a type "A" mounting). The coefficients shall meet or exceed a 3.0 P.C.F. density material rating. Insulation shall meet the erosion requirements of UL 181 facing the air stream and fire hazard classification of 25/50 (per ASTM-84 and UL 723 and CAN/ULC S102-M88) and meet NFPA 90A and 90B. All insulation edges shall be encapsulated within the panel. All perforated sections shall have Micromat® or equal insulation with non-woven mat facing, 5000 fpm rating and non-hygroscopic fibers as manufactured by Johns Manville or approved equal.
 9. Foam Injected Insulation – Solid steel liner sections to be insulated with a full 3” thick closed cell foam insulation. Foam shall be ecomate 0-, 0-, (Non VOC) UL 94HF1 rated. All insulation edges shall be encapsulated within the panel. All field penetrations must be completely sealed by installing contractor. Non UL 94HF1 rated foam is not allowed.
 10. Access Doors - The unit shall be equipped with a solid double wall insulated (same as the unit casing), hinged access doors as shown on the plans. The doorframe shall be extruded aluminum, foam filled with a built in thermal break barrier and full perimeter gasket. The door hinge assembly shall be stainless steel. There shall be a minimum of two heavy duty handles per door. Provide ETL, UL 1995, and CAL-OSHA approved tool operated safety latch on all fan section access doors.
 11. Note: If manufacturer cannot provide thermal break door design it must be noted as an exception on the bid.

C. Unit Components

1. Fans and Fan Arrays
 - a. Fans shall be polymer airfoil wheel, direct drive arrangement and shall be individually housed. Fans shall tested in accordance with AMCA 210 for air performance and AMCA 300 for sound performance. Fan shall be housed in a “cell”.

- b. Fan housing or “cell” shall be constructed of aluminum or stainless steel with perforated inner liner, melamine insulation, with either solid or perforated outer panels as required by application.
 - c. Fan/motor assembly shall be mounted within the housing on an adjustable slide rail base. Fan/motor assembly must be capable of either horizontal or vertical application.
 - d. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, for fan application class BV-5, to meet or exceed a rotational imbalance Grade G1.0, producing a maximum rotational imbalance of 0.04 inches per second peak, filter in. “Filter in” measurement indicates that the specified balance grade must be achieved at the submitted design operating speed for the fan(s).
 - e. Fan assemblies shall be dynamically balanced to meet AMCA standard 204-96, for fan application class BV-4, to meet or exceed a rotational imbalance Grade G2.5, producing a maximum rotational imbalance of 0.10 inches per second peak, filter in. “Filter in” measurement indicates that the specified balance grade must be achieved at the submitted design operating speed for the fan(s).
 - f. Fan and motor assemblies shall be designed for application in multiple fan arrays.
2. Fan Backdraft Dampers
- a. Each fan applied in multiple fan applications shall be provided with an integral back flow prevention device that prohibits recirculation of air in the event a fan, or multiple fans, becomes disabled. The system effect for the submitted back flow prevention device shall be included in the calculation to determine the fan TSP for fan selection purposes and shall be indicated as a separate line item SP loss in the submitted fan selection data. Manufacturers other than the basis of design being submitted must provide independent lab certification of fan testing that indicates the system effects attributed to the submitted back flow prevention device in the submitted close coupled mounting arrangement at the inlet of the fan. Fans submitted with discharge dampers will not be approved.
 - b. Back Draft Damper performance data that is based on an AMCA ducted inlet and ducted discharge mounting configuration will not be accepted. Submitted Back flow prevention device data must be reflective of close coupled mounting at the intake of the fan(s) per the project design documents. Motorized dampers or other motorized devices submitted for back flow prevention are not acceptable.
 - c. AHU Manufacturers that do not manufacture the fans being submitted must provide tested and certified performance data for fans as installed in the AHU unit including the back draft damper system effects introduced by close coupled back draft dampers at the fan inlet.
3. Fan Airflow Monitoring
- a. Fans shall have non evasive, zero pressure drop flow a/o pressure sensing taps installed in the fan inlet cone for airflow monitoring capability as specified.
4. Motors
- a. Electronically Commutated Permanent magnet motors (ECM)
 - a) All EC motors shall be UL listed with brushless permanent magnet motors.
 - b) All bearings shall be permanently lubricated
 - c) Motors shall have a design life of L10 100,000 hours
 - d) Motors shall have a means of shaft isolation to prevent electrical arcing across bearings

- e) Motors shall be complete with electronic motor overload protection, locked rotor protection and thermal management
 - f) Motors shall meet IP54 protection and thermal class THCL 155
- 5. Multiple Fan Arrays
 - a. The fan array shall consist of multiple housed fans or “cells”, spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air tunnel cross section and components contained therein.
 - b. Each fan and motor assembly shall be removable through a 24” wide, free area, access door located on the discharge side of the fan wall array without removing the fan wheel from the motor.
 - c. All fans in the multiple fan arrays shall be AMCA certified for performance per AMCA arrangement “A” testing configuration. The submitted fan performance shall be inclusive of system effects attributed to the fan mounting arrangement, fan enclosures, back draft dampers, and other fan appurtenances not considered when AMCA certified performance per AMCA arr. “A” is determined. Submitted AHU/fan performance that does not indicate allowances for system effects for the backflow prevention device(s), wheel enclosures, safety screens, bearing pedestals, belt guards, or the fan and motor enclosure in which each fan is mounted, will be returned to the contractor disapproved and will need to be resubmitted with all the requested information included for approval. Added system effects for other devices required to meet specified fan performance and sound levels must be indicated in the submitted fan selection data.
 - d. Fan system power requirements or sound power levels that fail to meet specified performance levels shall be corrected to meet specified performance levels at no additional cost to the owner. Any proposed corrections for power or sound deviations from specified values must be submitted to the engineer for approval prior to implementation of any proposed corrective procedure.
 - e. Submittals for units providing less than the scheduled quantity of fans and/or spacing of the fans for multiple fan arrays shall submit CFD modeling of the air flow profile for approval that indicates uniform velocity and flow across all internal components without increasing the length of the AHU unit or changing the aspect ratio of the unit casing as designed.
 - f. Manufacturers that do not manufacture their own fans for the specific purpose of use in multiple fan arrays, shall provide a letter guaranteeing submitted AHU performance for flow, pressure, and acoustics at the perimeter boundary of the unit signed by an officer of the OEM fan manufacturer being submitted. Any corrective acoustical treatment, added airway tunnel lengths, increased electrical service, and any structural modifications necessary to meet specified and scheduled performance shall be provided at no additional cost to the owner to meet the specified performance criteria. All proposed corrective actions, when required, must be submitted for approval and shall include a guarantee of performance, as listed above, at no additional cost to the owner.
- 6. Acoustical Performance
 - a. The AHU unit shall provide the specified acoustical performance as scheduled for the unit supply discharge opening(s), RA opening(s), and the Outside air and Exhaust air opening(s).
 - b. Coplanar silencer(s) and/or sound attenuator(s) shall be provided to meet specified acoustical requirements. Sound attenuator cross sectional area shall be selected to

- not exceed 500 fpm. Losses from sound attenuating devices must be included in the fan performance selection.
- c. Listed or alternate manufacturers, other than the basis of design, providing fan arrays that incorporate fans which are not manufactured by the AHU manufacturer, must provide modeled acoustical performance of the AHU unit.
 - d. Sound and performance data for approval showing only single fan performance for multiple fan array application will be returned without review.
 - e. Any proposed remedy for deviations in submitted sound power levels shall be approved by a registered acoustical consultant as selected by the owner or architect. Costs for review of proposed changes shall be borne by the contractor.
7. Heat Transfer Coils – Water Coil
- a. All coil assemblies shall be leak tested under water at 315 PSIG and PERFORMANCE is to be CERTIFIED under AHRI Standard 410. Coils exceeding the range of AHRI standard rating conditions shall be noted.
 - b. Cooling coils shall be mounted on stainless steel support rack to permit coils to slide out individually from the unit. Provide intermediate drain pans on all stacked cooling coils. The intermediate pan shall drain to the main drain pan through a copper downspout. Water coils shall be constructed of seamless copper tubing mechanically expanded into fin collars. All fins shall be continuous within the coil casing to eliminate carryover inherent with a split fin design. Fins are die formed Plate type.
 - c. Headers are to be seamless copper with die formed tube holes.
 - d. Connections shall be male pipe thread (MPT) Schedule 40 Red Brass with 1/8" vent and drain provided on coil header for coil drainage. All coil connections shall be extended to the exterior of the unit casing by the manufacturer. Coils shall be suitable for 250 PSIG working pressure. Intermediate tube supports shall be supplied on coils over 44" fin length with an additional support every 42" multiple thereafter.
 - e. Water coils shall have the following construction:
 - a) 5/8" o.d. x .020" wall copper tube with 0.028 return bends.
 - b) 0.008" aluminum fins
 - c) 16 gauge galvanized steel casing on heating coils
 - d) 16 gauge stainless steel casing on cooling coils
8. Condensate / Drain Pans - IAQ style drain pans shall be provided under preheat, cooling and reheat coils as shown on the drawings. The drain pan shall be fabricated from 16 gauge 304 stainless steel. All pans are to be triple pitched for complete drainage with no standing water in the unit. They shall be insulated minimum 3-inch "Double Bottom" construction with welded corners. Provide stainless steel, 1-1/4" MPT drain connection extended to the exterior of the unit base rail. Units in excess of 159 inches shall have drain connections on both sides. All cooling coil drain connections shall be piped and trapped separately for proper drainage. All drain pans at heating coils shall be capped at base rail.
9. Filters - Provide filters of the type indicated on the schedule. Factory fabricated filter sections shall be of the same construction and finish as the unit. Face loaded pre and final filters shall have Type 8 frames as manufactured by AAF, FARR or equal. Side service filter sections shall include hinged access doors on both sides of the unit. Internal blank-offs shall be provided by the air unit manufacturer as required to prevent air bypass around the filters. The filters shall be as manufactured by Farr, Purolator, AAF or equal. Filters shall be in compliance with ANSI/UL 900 – Test Performance of Air Filters.

10. Filter Gauge: Each Filter bank shall be furnished with: (Magnehelic / Photohelic) filter gauge with a 4 3/4" OD white static pressure dial with black figures and zero pointer adjustment. Dwyer Series 2000 Air filter gauge, Dwyer Mark 25 Inclined manometer (DWYER 250 AF).
11. Flat Racks - Filter racks shall be completely factory assembled and designed for industrial applications. Filter racks shall be fabricated from no less than 16 gauge galvanized steel. Filter racks shall be applied in low efficiency filter applications and will be either upstream or side accessible. Side accessible filter racks shall have an oversized access door on the exterior of the air handler, centered on the filter rack for easy filter removal. Upstream access filter racks shall have one central access cover per row of filters centered in the unit for easy access. Filter racks over 72" in length shall require an angle center reinforcement support. Filter racks shall be designed for a maximum of 500 fpm, or meet or exceed the area specified in the mechanical schedule.
12. Medium Efficiency Pleated Filters - Filters shall be 2" thick, 30% efficient. Filter media shall be 100% synthetic. The filter shall have an average efficiency of 25 30% and an average resistance of 90 92%. The filters shall be listed as Class II under UL Standard 900. Filters shall be tested per ASHRAE Standard 52-76. The effective media shall not be less than 4.6 square feet of media per 1.0 square foot of filter face area, and shall contain not less than 15 pleats per linear foot. Initial arrestance at 500 fpm approach shall not exceed 0.28" wg.
13. High Efficiency Bag Filters - Filters shall be a high performance extended area disposable type. Each filter shall consist of high density glass fibers, reinforced to form a lofted filter blanket. Filters shall be furnished with individual dust holding compartments and a corrosion resistant galvanized steel enclosing frame. Dust holding compartments shall consist of glass fibers bonded to a reinforced backing. The configuration of the dust holding compartments shall be controlled by means of progressive link stitching. The stitching shall be such that it forms a supported compartment resulting in uniform velocities in the passages of the entering air and exit air side of the filter. The dust holding compartment shall be equipped with a minimum of 48 support points per square foot of the filter media. All stitching points shall be sealed with a hot melt adhesive or equivalent. The dust holding compartment shall be equipped with a galvanized entry faceplate which becomes an integral part of the enclosing frame. The filter unit shall be completely factory assembled and shall be classified by UL as Class II under UL Standard 900. The filter efficiency shall be Merv14 meeting the efficiency specified by the mechanical schedule. The filter efficiency and arrestance shall be in accordance with ASHRAE Standard 52.1-1996.

D. Dampers

1. Dampers shall be constructed from minimum 12 gauge extruded aluminum blades and frames. Blades shall be locked to the blade shaft by a positive means other than setscrews. Such means include ribs extruded into the blade that fit slots in the damper shaft and hexagonal shafts that fit tightly in hexagonal holes extruded into the blades.
2. Shafts shall be provided with bearings at all support locations.
3. Dampers shall be equipped with blade and jamb seals and shall have a leakage rate less than .1% of maximum flow.
4. Linkage shall be concealed in the jamb out of the air stream where such an arrangement will be accessible for maintenance and lubrication without removal of the unit from the duct system or fan system that it is installed in. In all other cases the linkage shall not be concealed in the frame.

5. Dampers with vertically oriented blades shall be provided with thrust bearings to support the vertical blades.
 6. Mixed Air Section Damper and Outdoor Air Section Dampers shall be vertical blade to promote air mixing.
 7. Dampers shall be Ruskin Model CD-50 or approved equal.
- E. Electrical Power and Controls
1. All electrical and automatic control devices not previously called out or listed below are to be furnished and installed in the field by OTHERS.
 2. All wiring shall be (75°C) Insulated copper wires.
 3. The unit shall feature a mounted permanent nameplate displaying at a minimum the manufacturer, serial number, model number and current and amps voltage. The unit must have an ETL or UL Listing and bear the appropriate mark.
 4. Conduit shall consist of a combination of EMT or flexible metal conduit as required. Liquidtight flexible metal conduit may be used outside the air tunnel for wet locations. All electrical wiring shall be installed in EMT conduit where possible. Flexible conduit use shall be limited.
 5. Provide two (2) 1-inch EMT conduits empty for field installed temperature controls low voltage wiring. Provide conduits in each supply and return air tunnels the entire length of the unit.
 6. The unit shall feature a main non-fused disconnect of the proper amp rating to allow shutoff of all electrical motors and control items. This disconnect shall be located in the electrical compartment.
 7. All EC fan motors shall be wired to a junction box mounted in the electrical compartment.
- F. Unit Convenience Features
1. All fan motors, energy recovery wheel motors shall be wired to a single electrical panel in the electrical compartment for an external 480Volt, 3 Phase source.
 2. Each section shall be equipped with a vapor- proof LED strip light equal to a minimum of 100 watt with guard.
 3. Lights shall be controlled by one light switch mounted on the exterior of the cabinet.
 4. All lights, switches and outlets shall be wired to a non-fused disconnect for a separate 120 volt external source.
 5. All shipping splits shall have electrical connections clearly labeled for field installation. The mechanical contractor shall coordinate field connection with electrical contractor.
- G. Energy Recovery Wheel
1. General
 - a. Refer to unit schedules to identify units that require wheels.
 - b. Furnish and install the I3 energy recovery wheel, to be manufactured by Innergy tech Inc. or equal by Thermotech Inc. or approved equal.
 - c. The energy recovery wheel shall transfer both sensible and latent energies between outgoing and incoming air streams in a counter flow arrangement.
 - d. The energy recovery wheel shall be labeled for rotation direction and airflows (Outdoor air & Exhaust air).
 - e. The energy recovery wheel manufacturer must have at least ten (10) years of experience in the manufacturing of energy recovery components.

- f. The energy recovery wheel shall carry a full parts and labor 5 years warranty from the date of shipment. An optional 10 years warranty shall be available as a separate option.
- 2. Quality Assurance
 - a. The wheel shall bear the AHRI 1060 certified label. Wheels tested in independent laboratories, whether according to AHRI Standard 1060 or not, are not acceptable unless actually certified by AHRI. Wheel manufacturer membership in AHRI is not an acceptable substitute for AHRI certified performance.
 - b. The energy recovery wheel shall be a UR recognized component and bear the UR label.
 - c. The energy recovery wheel shall comply with the requirements of UL723. The media shall have a flame spread of less than 25 and a smoke developed of less than 50 when rated in accordance with ASTM E87.
 - d. The energy recovery wheel shall comply with the IBC Certification and OSHPD Seismic Qualifications.
 - e. The manufacturer's quality procedures shall be ISO 9001-2008 certified.
- 3. Performances (Effectiveness, Pressure drop, EATR & OACF)
 - a. Sensible, latent and total effectiveness along with pressure drop, EATR and OACF ratings, shall be clearly documented in the AHRI 1060 Certified Product Directory.
 - b. The energy recovery wheel, without purge, shall achieve an EATR rating of 0% (no cross-leakage) at 5" WC pressure differential. The result shall be clearly shown in the AHRI 1060 directory.
 - c. To reduce fan operating costs, the energy recovery wheel shall not exceed an OACF of 1.15 for rotors of up to 70" (1778mm) and 1.08 for rotors of up to 120" (3048mm) at 5" WC pressure differential when no purge is used. The results shall be clearly shown in the AHRI 1060 directory.
- 4. Rotor Media & desiccant
 - a. The rotor media shall be made of 2 mils minimum thickness aluminum. The media shall be coated to prohibit corrosion and shall be suitable for seacoast application. Non-metallic substrates made from paper, plastic, synthetic or glass fiber media are not acceptable.
 - b. All surfaces shall be coated with a non-migrating desiccant specifically developed for water transfer in vapor phase. Etched or oxidized surfaces are not acceptable.
 - c. Desiccant must be a polymer hygroscopic or 3 angstroms molecular sieve (3A).
 - d. Desiccant shall be bactericide and non-corrosive.
 - e. The rotor shall be constructed of equal width, alternate layers of corrugated and flat aluminum sheet material to create a flat and smooth surface and insure laminar flow thus preventing any dust or particles accumulation inside the rotor.
 - f. Corrugation pattern shall be of closed triangular shape to prevent any cross-leakage between airstreams. Open type corrugations or embossments, since they increase fan operating costs, are not acceptable.
 - g. Dry particles up to 800 microns shall freely pass through the media to minimize air pressure drops and pre-filtering requirements.
- 5. Seals
 - a. The rotor shall be supplied with labyrinth seals facing the media, polymer contact seal along the depth of the wheel and "S" type labyrinth seal along the wheel's periphery. Wheel using less effective seals like brush seals or standard 4 pass labyrinth seals are not acceptable.

- b. The labyrinth seals shall be installed with no gap between the seal and media. Labyrinth seals that require an installation gap or seals that will damage the media if they come in contact with it are not acceptable.
 - c. All seals shall be designed to withstand pressure differentials of up to 10"WC.
 - d. The labyrinth seals shall be factory adjusted. Field adjustments shall be possible using common tools.
- 6. Bearings and center shaft
 - a. The rotor shall be supported by two pillow block bearings which can be maintained or replaced without removal of the rotor from its casing or the media from its spoke system. Inboard type bearings are not acceptable. Grease fittings shall be easily accessible.
 - b. Bearings shall be rated for a minimum L10 life of 220,000 hours.
 - c. The center shaft shall be machined as to provide a shoulder against the bearing and prevent any axial movement of the rotor.
 - d. The center shaft shall use black oxide and oil coating to prevent rust. Center shafts using oil only are not acceptable.
- 7. Purge & Cassette Assembly
 - a. The unit shall be provided with a factory set & field adjustable purge section to prevent any cross-leakage (0% EATR) starting for pressure differentials as low as 0.5"WC.
 - b. The rotor shall be provided with a structural frame which limits the deflection of the rotor due to air pressure drops to less than 1/32".
 - c. The framing shall be made of a heavy-duty welded tubular steel assembly.
 - d. Framing shall be primed with a rust inhibitor phenolic primer and painted with a high durability synthetic industrial paint.
 - e. The cover panels shall be made of galvanized steel (minimum thickness of 1/16") to prevent corrosion.
 - f. When the top/bottom & side plate option is selected, the cassette shall be equipped with removable cover panels for side service access to the motor assembly.
 - g. For easier parts inspection and maintenance, all major components (motor assembly, driving belt, seals) shall be easily accessible from at least one side of the wheel within the airstream. The components shall not require the removal of sheet metal for a visual inspection. Wheels with face plates on both sides are not acceptable.
 - h. The wheel shall be supplied with removable corner bracings (bolted) for easy replacement of media sections from both faces of the wheel if ever required.
- 8. Rotor assembly
 - a. Rotor spoke system shall be of segmented design to allow for field erection or replacement of one section at a time without requiring side access. Wheels up to 62" in diameter shall be made of 4 sections and wheels larger than 62" shall be made of 8 sections.
 - b. The rotor spoke system shall be made of strong aluminum material providing the structural integrity required at design pressure differentials.
 - c. The rotor hub shall be made of machined, extruded aluminum (no welding), for reduced tolerance and increased stiffness.
 - d. All rotor parts shall be made of aluminum or stainless steel. Galvanized steel parts are not acceptable.
- 9. Drive system

- a. The rotor shall be perimeter driven with a multilink V-belt made of high-tech polyurethane/polyester composite material for easier installation and replacement.
 - b. V-belt shall be easily adjustable without the use of tools.
 - c. The belt shall be tensioned with a heavy-duty belt tensioner. Gravity tensioned assemblies are not acceptable.
 - d. An A/C inverter duty motor shall drive the rotor.
 - e. The wheel shall be supplied with a speed reducer resulting in a rotation speed of 20RPM without the use of a VFD. Wheels with rotation speed higher than 20RPM are not acceptable due to increased fan energy consumption.
 - f. Speed reducer and belt tensioner shall be permanently lubricated and maintenance free.
10. Controls
- a. The VFD shall be supplied with a NEMA 1 enclosure and located in the electrical compartment. The VFD shall be by ABB, no exceptions.
 - b. The VFD standard communication protocol shall be: S-422/485 MEMOBUS/Modbus at 115.2 kbps (BACnet™ optional).
 - c. VFD to be supplied with LCD display screen for easy monitoring of VFD parameters, inputs and outputs.
 - d. Communication Capabilities: VFD software to enable building automation system (BAS) to monitor temperatures, control discharge set point, wheel rotation speed and display alarms.

2.5 INDIRECT GAS-FIRED AIR HANDLING UNITS

- A. Furnish and install air handling units as specified below, and as described in diagrams and schedules on the drawings. The unit shall include frame casing, insulated drain pans, heating and cooling coils, fan assemblies, access panels for easy access to all service points, bearings, motors and drives and guards.
- B. The units shall be constructed of welded or bolted angle or channel steel frames. The entire frame assembly shall be hot dipped galvanized after fabrication, or suitably treated with a rust inhibitor coating. The casing shall be 2-inch solid double wall G90 galvanized metal with foam injected panels. The casing shall be rated per ASHRAE/ANSI 1350 to meet or exceed the following: L/240 deflection at 8" positive and negative pressures – Class CD2; Class CL6 Leakage at 8" positive and negative pressures; R-13 Class CT1; Thermal bridging Class CB0. Hinged access doors with camlocks and heavy duty hinges shall be provided for ready access to bearings, motors, drives, coils, piping devices and connections, and other points required for maintenance service or inspection. Condensate drain pans shall be installed with 2" of insulation provided between the drain pan and the casing and shall drain both the coil and the fan; units with multiple vertically stacked coils shall have an intermediate drain pan. The pans shall be of continuously welded seams, Series 300 stainless steel construction, 'V' shaped and/or sloping to the drain connection, flat pans will not be acceptable. Drain pans shall be located in the coil section and in the fan section.
- C. Indoor units: Entire air handling unit shall set on base rails to allow deep condensate trap and where shown on the plans extended base rails shall be provided to support external filter housing and sheet metal transitions. Base rails shall be a minimum of 6" height where no size is indicated on the plans.

- D. Outdoor units: Roof shall be cross-broken and pitched with "C" caps over joints to provide watertight seal.
- E. Fans shall have capacities and minimum wheel diameters as indicated on the schedules. Each fan shall be of the non- overloading centrifugal type with deep drawn inlet rings, streamlined housing and scroll, with blades continuously welded to the flange, solid backplate, full curved shroud, and flanged discharge collar. Where Class II construction is required, wheels shall be reinforced with a welded intermediate ring. Fan bearings shall be heavy duty, self-aligning, grease lubricated, antifriction type with double row rollers and labyrinth grease seals. Grease fittings shall be extended through the unit housing. Provide drain openings at the bottom of each fan scroll. Each fan shall be equipped with an adjustable pitch V-belt drive selected for 1.5 times the motor horsepower, motor slide rail base and dripproof motor. Fans and motors shall be resiliently mounted on a single structural base, internally mounted with resilient mounts on the unit structural frame. Fans shall be airfoil or backward inclined as scheduled. Forward curved fans may be used only where specifically scheduled. Internal resilient mounting shall be spring type with minimum 1-1/2" static deflection and provided with seismic restraints.
- F. Manufacturer shall use the most energy efficient fan option within the manufacturer's line for the unit size but in no case will the wheel be smaller than the diameters scheduled.
- G. Burner: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
 - 1. CSA Approval: Designed and certified by and bearing label of CSA.
 - 2. Construction: [Aluminized steel with stainless-steel inserts] [Stainless steel].
 - 3. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.
 - 4. Combustion-Air Intake: Separate combustion-air intake and vent terminal assembly.
 - 5. Heat Exchanger: [Aluminized] [Stainless] steel.
 - 6. Heat-Exchanger Drain Pan: Stainless steel.
 - 7. Safety Controls:
 - a. Gas Manifold: Safety switches and controls complying with ANSI standards [and] [FM Global] <Insert insurer>.
 - b. Vent Flow Verification: [Differential pressure switch to verify open vent] [Flame rollout switch].
 - c. High Limit: Thermal switch or fuse to stop burner.
 - d. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
 - e. Airflow proving switch feature in "Airflow Proving Switch" Subparagraph below is provided by some manufacturers; consult manufacturers.
 - f. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
 - g. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
 - h. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.
 - i. Control Transformer: 24 V ac.

PART 3 - EXECUTION

3.1 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. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Furnish and install air handling units as shown and scheduled on the drawings.
- B. Equipment Mounting:
 - 1. Install air-handling units on cast-in-place concrete equipment bases. Coordinate sizes and locations of concrete bases with actual equipment provided.
 - 2. Comply with requirements for vibration isolation and seismic-control devices specified.
- C. Suspended Units: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers.
- D. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- E. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- F. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.
- G. Coordinate duct installations and specialty arrangements with schematics.
- H. Connect duct to air-handling units with flexible connections.

3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to air-handling unit, allow for service and maintenance.

- C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- E. Hot- and Chilled-Water Piping: Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
- F. Steam and Condensate Piping: Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection. Install gate valve and inlet strainer at supply connection of dry steam humidifiers, and inverted bucket steam trap to condensate return connection.
- G. Refrigerant Piping: Install shutoff valve and union or flange at each supply and return connection.
 - 1.
 - 2.

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Division 26"
- B. Ground equipment according to Division 26.
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Divisions 25 and 26.

3.6 STARTUP SERVICE

- A. [Engage a factory-authorized service representative to perform] [Perform] startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that shipping, blocking, and bracing are removed.
 - 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 - 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.

5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 6. Verify that zone dampers fully open and close for each zone.
 7. Verify that face-and-bypass dampers provide full face flow.
 8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 9. Comb coil fins for parallel orientation.
 10. Verify that proper thermal-overload protection is installed for electric coils.
 11. Install new, clean filters.
 12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- B. Starting procedures for air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.[Replace fan and motor pulleys as required to achieve design conditions.]
 2. Measure and record motor electrical values for voltage and amperage.
 3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.7 CLEANING AND PROTECTION

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

- A. [Engage a factory-authorized service representative to train] [Train] Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 23 73 00

SECTION 23 74 00 – PACKAGED OUTDOOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Packaged small capacity rooftop units
 - 2. Packaged large capacity double wall rooftop units

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Packaged Rooftop Units
 - 1. Aeon
 - 2. Carrier
 - 3. Daikin
 - 4. JCI
 - 5. Trane

2.3 PACKAGED SMALL CAPACITY ROOFTOP UNITS 0 – 10 TONS

- A. Furnish and install packaged rooftop units of the capacities scheduled. The units shall be factory assembled, wired, refrigerant charged and tested prior to shipment. Units shall be UL listed and labeled.
- B. Unit shall be casing constructed of all galvanized materials with the exterior surfaces painted. The entire cabinet shall be insulated and sealed watertight.
- C. Compressors shall be hermetic reciprocating or scroll type. Compressors shall have current overloads, temperature overloads, and crank case heaters. The compressor shall be in separate cabinet from the fan section and shall have spring vibration isolators and additional sound proofing. Compressor shall operate down to 0°F ambient.
- D. The evaporator and condensing coils shall be copper tubes with mechanically bonded aluminum plate fins. The refrigeration circuit shall have filter drier, sight glass, and service ports.
- E. The supply fan shall be a non-overloading forward curve fan sized for high efficiency within the range of normal airflows. The motor and drive shall be selected to provide the design airflow and external static pressure as scheduled on the plans. The motor shall contain overload protection.
- F. The unit shall contain a terminal strip for customer interface. The following shall be provided as a minimum: Fan start/stop and compressor enable/disable.
- G. The unit shall be supplied with a down flow roof curb factory matched to the unit and allow direct ductwork connections. The finished height of the roof curb shall be 10" – 12" above the finished roof. The Contractors shall coordinate the curbs with the roof insulation thickness.
- H. The unit shall have a single point connection and shall not exceed the scheduled power consumption.

2.4 PACKAGED LARGE CAPACITY DOUBLE WALL ROOFTOP UNITS

- A. Units shall be [electric cooling only, combination electric cooling/electric heat, combination electric cooling/gas heat] packaged rooftop equipment as scheduled on the drawings and specified herein. Units shall be fully factory assembled UL Standard 465 listed and labeled package consisting of an insulated weathertight casing, compressor(s), air cooled condenser coil, condenser fans and motors, evaporator coil, filters, [supply fan/exhaust fan], fan motors and drives, [heater], and unit controls.
- B. Cooling performance shall be tested and certified to ARI Standard 210/240-89 or 360-85. Units shall be factory charged and 100% factory run tested for proper operation of all standard and optional items including: fans, compressors, expansion valves [heater], safeties, and controls. A copy of a run test report indicating the date, time, tested refrigerant temperatures/pressures, amperages, voltages, etc. shall be shipped with the unit.
- C. Unit casing shall be a minimum of 18 ga. G90 galvanized steel. Exterior surfaces shall be cleaned, phosphatized and finished with a baked enamel finish to meet a 500 hour salt spray test

in accordance with ASTM B117. Roof panels shall be cross broken and/or sloped to provide positive drainage. The interior airside of the cabinet shall be entirely insulated on all exterior panel with a minimum of 1 inch thick, 1 pound density, neoprene coated fiberglass insulation. [The unit shall have a minimum of 20 ga. G90 galvanized steel solid interior liner.] [The unit shall have a minimum of 20 ga. G90 galvanized steel perforated interior liner.] [Heater sections shall have a minimum of foil faced insulation or a matching metal liner equal to the rest of the unit as specified.] Access door shall be double wall construction with stainless steel piano hinges, quarter-turn camlocks (door fastening screws are not acceptable), fully gasketed with rain breaks. Access doors shall be provided for ready access to bearings, motors, drives, coils, piping devices and connections, and points required for maintenance service or inspection. Condensate drain pans shall be insulated with full thickness, non-compressed, insulation between the drain pan and the unit casing and shall drain both the coil and the fan; units with multiple vertically stacked coils shall have an intermediate drain pan. The pans shall be continuously welded seams, Series 300 stainless steel, 'V' shaped and/or sloping to the drain connection, flat pans will not be acceptable. Drain pans shall be located in the coil section and in the fan section. The finished height of the roof curb shall be 10" – 12" above the finished roof. The Contractors shall coordinate the curbs with the roof insulation thickness.

- D. Compressor shall be isolator mounted, high efficient, hermetically sealed, refrigerant cooled, reciprocating or scroll type with high starting torque. Motor shall be capable of operating at plus/minus 10 percent of nameplate voltage. Motor shall have internal temperature and current sensors for motor protection. Units larger than 7 tons shall have multiple compressors with a minimum of two stages of control. Each compressor shall have separate refrigeration circuits each with a thermostatic expansion valve. Each compressor shall have an automatic resetting low pressure safety and a manual reset high pressure safety. Refrigeration filter-drier, sight glass, liquid service valve, suction service valve, and gauge ports shall be factory furnished and installed.
- E. Condenser coils shall be 3/8" smooth bore copper tubes with aluminum fins mechanically bonded to the tubes. Fins shall not be spaced closer than 12 fins per inch. Provide subcooling circuits integral with the condenser coils for a minimum of 10°F subcooling. Coils shall be factory pressure tested to 425 psig. [PVC coated metal coils guards shall be factory installed for coil protection]. [Coil guards shall be a minimum of 20 ga. galvanized steel louver type to protect the coil from hail or other damage, wireguards are not acceptable.] Condenser fan(s) shall be aluminum or galvanized steel blades with non-corrosive hubs. Fan motors shall be direct connected, totally enclosed, permanent split capacitor type, with built-in thermal overload protection.
- F. Fans shall have capacities as indicated on the schedules. Each fan shall be of the non-overloading airfoil or backward inclined centrifugal type with deep drawn inlet rings, streamlined housing and scroll, with blades continuously welded to the flange, solid backplate, full curved shroud, and flanged discharge collar. Where Class II construction is required, wheels shall be reinforced with a welded intermediate ring. Fan bearings shall be heavy duty, self-aligning, grease lubricated, antifriction type with double row rollers and labyrinth grease seals. Provide drain openings at the bottom of each fan scroll. Each fan shall be equipped with an adjustable pitch V-belt drive selected for 1.5 times the motor horsepower, motor slide rail base and premium efficiency open dripproof motor. Fans and motors shall be resiliently mounted on a single structural base, internally mounted with resilient mounts on the unit structural frame. Internal resilient mounting shall be spring type with minimum 1-1/2" static deflection and provided with seismic restraints. [Forward curved fans may be used only where scheduled.]

1. Manufacturer shall allow for using the most energy efficient fan option within the manufacturer's line for the unit size [but in no case will the wheel be smaller than the diameters scheduled and shall be of the same wheel type scheduled.] The Engineer reserves the right to choose the final fan size from the manufacturer's line.
- G. The units shall be provided with coils of the types and capacities scheduled. Cooling coil casing shall be galvanized steel. Coils shall be constructed with no less than ½" diameter x .020" wall thickness copper tubes and .0075" aluminum or copper fins spaced not closer than 10 per inch. Fins shall be permanently secured to the tubes by mechanical bonding or soldering and shall be plate type. Frame shall include intermediate tube supports to prevent sagging of the tubes. The coil shall be removable with removing casing panels (i.e., casing shall have its own internal frame and shall not use the coil for support).
 1. [Water coil] headers and "U" bends shall be arranged so that the entrained air is carried along with the flow of water through the coil to the high point on the leaving water header. High points in the coil shall be provided with vent connections. Multi-row coils shall be arranged for counterflow heat exchange between the air and water.
 2. [Refrigerant coils] shall be row split or interlaced type with equalizing distributors. Coils shall be tested to 300 psig and shipped with a holding charge of dry nitrogen. Tube diameters, wall thickness, and fins shall be the same as above.
- H. Air filters shall mount integral within the unit casing on slide channels. The channel shall incorporate a positive sealing gasket material to seal the top and bottom of the filter to prevent bypass. Access door(s) with the same construction as specified previously, and shall be located to allow easy replacement of the filters. Filters shall be [2" replaceable media, 2" pleated 30% throw-away, 4" pleated 30% throw-away]. Filters that are 24" x 24" size are preferred to reduce the required inventory, thus facilitating better maintenance.
- I. Units shall have a factory furnished and wired non-fused single point power disconnect switch and fused 24 volt control power transformer. The disconnect switch handle shall be accessible without opening any unit access doors. The unit shall be provided with a factory furnished and wired GFI 120V outlet that the transformer (460 models) is powered from the line side of the incoming three phase power, so that the outlet can remain powered when the three phase disconnect is off. The receptacle shall be fused and have disconnects, overload protection, etc., per the NEC.
- J. Units shall be completely factory wired with terminal block connections for all customer wiring interfaces. A wiring diagram specific to the unit ordered (with only the options actually provided) shall be shipped with the unit. Factory controls shall include: anti-short circuit time delay relay(s), low ambient temperature start-up and control down to 40°F [0°F], pump down cycle, and coil frost control. A customer terminal strip shall be provided to enable control of the following functions: start/stop, fan proof of operation, heater control (each stage), economizer damper control (4-20 mA), cooling control (each stage), dirty filter switch, fan speed control (4-20 mA), and safety shutdown indication (N.O. contact).
- K. Units shall have a complete one year warranty and a five year warranty on the compressor (and a 10 year warranty on the gas heat exchanger).

2.5 PACKAGED DOUBLE WALL ROOFTOP UNITS

- A. Furnish and install rooftop units as specified below, and as described in diagrams and schedules on the drawings.
- B. Factory assembled and tested; designed for roof or slab installation; and consisting of compressors, condensers, evaporator coils, condenser and evaporator fans, refrigeration, gas-fired heating, filters, and dampers.
- C. Unit shall be completely factory assembled, piped and wired and shipped in one section. Unit shall be specifically designed for outdoor roof top application with a fully weatherproof cabinet.
- D. All cabinet walls, access doors, roof and floor shall be a high performance composite panel constructed with G90 galvanized steel on both sides and a closed cell polyurethane foam interior core providing a rigid, impact resistant surface.
 - 1. The walls of the air tunnel compartments shall be 2 inches thick with a minimum R value of 12.5.
 - 2. The walls of the coil compartment shall be 1 ½ inches thick with a minimum R value of 9.4.
 - 3. The roof of the air tunnel compartments shall be sloped at a minimum of ¼ inch per foot and shall be an average of 2 ½ inches thick and an R value of 15.7.
 - 4. The floor of the conditioned air and control compartments shall be 1 inch thick with a minimum R value of 6.25.
 - 5. The access doors shall be 1 ½ inches thick with a minimum R value of 9.4.
 - 6. The foam shall have a minimum density of 2 pounds per cubic feet.
 - 7. All foam material shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610 degrees F.
 - 8. All panels shall have a thermal break with no metal path from inside to outside.
- E. Paint finish shall be capable of withstanding at least 2000 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
- F. Unit specific color coded wiring diagrams shall match the unit color coded wiring and will be provided in both point-to-point and ladder form. Diagrams shall also be laminated in plastic and permanently affixed inside the control compartment.
- G. Access to filters, heating section, and other items needing periodic checking or maintenance shall be through hinged access doors with quarter turn lockable latches. Door fastening screws are not acceptable. The blower access door shall be bolted closed.
- H. Access doors shall have stainless steel hinges and full perimeter gasketing.
- I. All openings through the base pan of the unit shall have upturned flanges of at least 1/2" in height around the opening through the base pan.
- J. Air side service access doors shall have rain break overhangs.
- K. Unit shall have decals and tags to indicate unit lifting and rigging, service areas and caution areas. Installation and maintenance manuals shall be supplied with each unit.

- L. Unit shall be furnished with 304 stainless steel drain pans.
- M. The fan shall be direct drive single width single inlet un-housed airfoil centrifugal, plenum fans. Supply fans shall have all aluminum construction. Fans attached to 1760 rpm motors shall be rated for a minimum of 1800 RPM maximum speed. Fans attached to 1170 rpm motors shall be rated for a minimum of 1200 RPM maximum speed. Direct drive fans shall be directly connected to and supported by the motor shaft. Motor bearings shall be rated for 200,000 hours service and shall have external lubrication connections. Fan(s) and motor(s) shall be dynamically balanced, and the entire fan assembly mounted on rubber isolators. Supply air shall be from the bottom of the cabinet. (Variable Volume Systems VFD drive(s) shall be factory mounted and wired to the fan motor(s).
- N. Outside Air shall be a fully modulating economizer for control by others with a DDC signal. The outside air damper and return air damper assembly shall be constructed of extruded aluminum, hollow core, air foil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 25 CFM of leakage per sq.ft. Of damper area when subjected to 2 in. w.g. air pressure differential across the damper. Damper motor shall be spring return to ensure closing of outdoor air damper during periods of unit shutdown or power failure.
- O. Air Cooled Condenser Section:
 - 1. The condensing section shall be equipped with vertical discharge axial flow direct drive fans. Direct drive fans shall be directly connected to and supported by the motor shaft.
 - 2. The condenser coils shall be sloped at least 30 degrees to protect the coils from damage.
 - 3. Condenser coils shall be copper tubes with aluminum fins mechanically bonded to the tubes.
 - 4. Condenser coils to be sized for a minimum of 10°F of refrigerant sub-cooling.
- P. Filter section shall have prefilter with 2-inch- thick, fiberglass, throwaway with an ASHRAE efficiency of 30%, 4" with 85% efficient filters, clogged filter switch and direct dial reading magnehelic gauge mounted in the control compartment.
- Q. Evaporator Coils:
 - 1. Evaporator coils shall be copper tube with aluminum fins mechanically bonded to the tubes.
 - 2. Evaporator coil drain pan(s) shall be fabricated of 304 stainless steel.
 - 3. Evaporator coils shall have galvanized steel end casings.
 - 4. Evaporator coils shall have equalizing type vertical tube headers.
 - 5. Evaporator coils shall be furnished with a thermostatic expansion valve.
 - 6. Evaporator coils shall be furnished with a double sloped drain pan for the positive drainage of condensate.
 - 7. A drain connection shall be provided on each side of the unit. The manufacturer shall provide a P-trap condensate drain fitting for field installation to the drain connections.
- R. Refrigeration System:
 - 1. Compressors shall be scroll type with internal thermal overload protection and mounted on the compressor manufacturer's recommended rubber vibration isolators. Each compressor shall have independent refrigerant circuits.
 - 2. Compressors shall be mounted in an isolated compartment to permit operation of the unit without affecting air flow when the door to the compartment is open.

3. Compressors shall be isolated from the base pan and supply air to avoid any transmission of noise from the compressor into the building area.
4. System shall be equipped with thermostatic expansion valve type refrigerant flow control.
5. System shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant controls.
6. Unit shall be equipped with Schrader type service fittings on both the high side and low pressure sides of the system.
7. Unit shall be equipped with refrigerant liquid line driers.
8. Unit shall be fully factory charged with refrigerant.
9. Hot gas bypass shall be provided on the first refrigerant circuit.
10. All circuits shall be equipped with liquid line sight glasses.
11. Unit shall be equipped with a 5 minute anti-short cycle delay timer for each stage.
12. Unit shall be equipped with 20 second between stage delay timers for each stage.
13. First stage cooling shall be provided to allow operation in low ambient to 0°F.
14. Each compressor shall be equipped with suction and discharge service valves.
15. Unit shall operate on R-410A refrigerant.

S. Energy Recovery Wheel

1. The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction and does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable.
2. The wheel capacity, air pressure drop and effectiveness shall be AHRI certified per AHRI Standard 1060. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Heat Exchangers For Energy Recovery Ventilation Equipment.
3. The rooftop unit shall be designed with a track so the entire energy recovery wheel cassette can slide out from the rooftop unit to facilitate cleaning.
4. The matrix design shall have channels to reduce cross contamination between the outdoor air and the exhaust air. The layers shall be effectively captured in aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belt(s) of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
5. The total energy recovery wheel shall be coated with silica gel desiccant permanently bonded without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
6. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place.
7. The exhaust air fan shall be a direct drive SWSI plenum fan. The exhaust fan shall be sized for the airflow requirements per the construction schedule. The unit controller shall control the exhaust fan to maintain building pressure. A VFD shall be provided for the

- exhaust fan motor or the exhaust fan motor shall be an ECM motor. The rooftop unit shall have single point electrical power connection and shall be ETL listed.
8. The control of the energy recovery wheel shall be an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed at the rooftop units DDC controller LCD display. All of these temperatures shall be made available through the BACnet interface.
 9. The rooftop unit with the energy recovery wheel shall incorporate the economizer operation. The energy recovery wheel shall have a bypass damper. When the unit is in the economizer mode of operation the energy recovery wheel shall stop and the bypass dampers shall be opened. The outdoor air shall be drawn through the bypass dampers to reduce the pressure drop of the outdoor airstream.
 10. The rooftop unit DDC controller shall provide frost control for the energy recovery wheel. When a frost condition is encountered the unit controller shall stop the wheel. When in the frost control mode the wheel shall be jogged periodically and not be allowed to stay in the stationary position.
- T. Heating Section
1. The rooftop unit shall include a natural gas heating section. The gas furnace design shall be one natural gas fired heating module factory installed downstream of the supply air fan in the heat section. The heating module shall be a tubular design with in-shot gas burners.
 2. The module shall be complete with furnace controller and control valve capable of modulating operation with the scheduled turndown.
 3. The heat exchanger tubes shall be constructed of stainless steel.
 4. The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.
 5. Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.
 6. The factory-installed DDC unit control system shall control the gas heat module. Field installed heating modules shall require a field ETL certification. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the gas heating modules.
- U. Factory Installed DDC Controls
- V. Unit shall be provided with a contact both in the return and supply air portion of unit and for electrical contactor to install smoke detectors in the field.
- W. Unit shall be provided with a firestat(s) sensing in both the return & supply air portion of the unit wired to shut off the unit control circuit.
- X. Unit shall be provided with a factory installed and wired internal disconnect. Unit shall be provided with phase and brown-out protection to shut down all motors in the unit if the phases are more than 10% out of balance on voltage, or the voltage is more than 10% under design voltage or on phase reversal. Unit shall be provided with a factory installed and wired 115 volt, 15 amp ground fault service receptacle powered with a 1.5 KVA transformer.

- Y. Roof curbs shall be constructed of galvanized steel. Curbs are to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasketing shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit. The finished height of the roof curb shall be 10" – 12" above the finished roof. The Contractors shall coordinate the curbs with the roof insulation thickness.
- Z. The units shall be AAON RM/RN/RQ, Daikin, JCI, Trane, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Furnish and install rooftop units as shown and scheduled on the drawings.
- B. Roof Curb: Install on roof structure or concrete base, level and secure, according to [NRCA's "NRCA Roofing Manual: Membrane Roof Systems."] [AHRI Guideline B.] Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction. Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment provided.

3.3 DUCT CONNECTIONS

- A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
- B. Install ducts to termination at top of roof curb.
- C. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
- D. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."

- E. Install return-air duct continuously through roof structure.

3.4 ELECTRICAL CONNECTIONS

- A. Connect electrical wiring according to Division 26.
- B. Ground equipment according to Division 26.
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Division 25 and 26.

3.6 STARTUP SERVICE

- A. [Engage a factory-authorized service representative to perform] [Perform] startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions.
 - 1. Inspect for visible damage to unit casing.
 - 2. Inspect for visible damage to furnace combustion chamber.
 - 3. Inspect for visible damage to compressor, coils, and fans.
 - 4. Inspect internal insulation.
 - 5. Verify that labels are clearly visible.
 - 6. Verify that clearances have been provided for servicing.
 - 7. Verify that controls are connected and operable.
 - 8. Verify that filters are installed.
 - 9. Clean condenser coil and inspect for construction debris.
 - 10. Clean furnace flue and inspect for construction debris.
 - 11. Connect and purge gas line.
 - 12. Remove packing from vibration isolators.
 - 13. Inspect operation of barometric relief dampers.
 - 14. Verify lubrication on fan and motor bearings.
 - 15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 - 16. Adjust fan belts to proper alignment and tension.
 - 17. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.
 - 18. Inspect and record performance of interlocks and protective devices; verify sequences.
 - 19. Operate unit for an initial period as recommended or required by manufacturer.
 - 20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.

- a. Measure gas pressure on manifold.
 - b. Inspect operation of power vents.
 - c. Measure combustion-air temperature at inlet to combustion chamber.
 - d. Measure flue-gas temperature at furnace discharge.
 - e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
- 21. Calibrate thermostats.
 - 22. Adjust and inspect high-temperature limits.
 - 23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.

3.7 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Occupancy Adjustments: When requested within [12months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [two] visits to Project during other-than-normal occupancy hours for this purpose.

3.8 CLEANING

- A. After completing system installation and testing, adjusting, and balancing RTUs and air-distribution systems and after completing startup service, clean RTUs internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

END OF SECTION 23 74 00

SECTION 23 81 00 – UNITARY HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Split-system Air Conditioning Units
 - 2. Condensing Units

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Split-system Air Conditioning Units
 - 1. Dakin
 - 2. Hitachi
 - 3. LG
 - 4. Trane/Mitsubishi
- B. Condensing Units
 - 1. Carrier
 - 2. Daikin

3. JCI
4. Trane

2.3 SPLIT SYSTEM AIR CONDITIONERS

- A. Furnish and install split system DX units as specified herein and as shown on the drawings. System shall consist of controls and all accessories.

B. INDOOR TERMINAL UNITS

1. Indoor terminal unit shall feature supply air fan, aluminum fin/copper tube cooling coil, housing and mounting bracket. Furnish and install packaged heat pump units of the capacities and operating conditions indicated on the plans. The units shall be factory assembled, wired, and tested prior to shipment. Units shall be ETL listed and labeled and consist of insulated casing, evaporator coil, electronic expansion valve, filter, supply fan(s), fan motor(s) & drive(s), and unit controls.
2. Cooling performance shall be tested and certified to ARI Standard 210/240-89 or 360-85. Units shall be 100% factory run tested for proper operation of all standard and optional items including: fans, expansion valves, safeties, and controls. A copy of a run test report indicating the date, time, tested refrigerant temperatures/pressures, amperages, voltages, etc. shall be shipped with the unit. The unit shall be shipped with refrigerant pipes factory charged with dehydrated air.
3. Unit casing shall be a minimum of 18 ga. G90 galvanized steel with an enamel finish and the interior airside of the cabinet shall be insulated. Condensate drain pans shall be insulated between the drain pan and the unit casing and shall come standard with a drain pump kit that pumps to a minimum of 9" from the drain pipe opening.
4. Coil: The evaporator coil shall be copper tubing with mechanically bonded aluminum plate fins.
5. Fans: Fans shall have capacities as indicated on the schedules. The fan shall be direct-drive type fan, statically and dynamically balanced impeller with high and low fan speeds available and a thermally protected motor.
6. Filters: Long-life 65% efficient mold-resistant filters shall come factory furnished with the unit
7. Sound: the cabinet shall be constructed with sound absorbing insulation and shall have sound pressures of a maximum of 43 dB(A) at low speed at a location of 5 feet below the suction grille.

C. CONDENSING UNITS:

1. Condensing units shall be ETL listed, fully assembled, piped, and wired packaged units, shipped as one piece, which are a current production line and fully cataloged by the manufacturer. Unit shall be shipped with a full refrigerant and oil charge. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.
2. Unit casing shall be removable service panels constructed of a minimum 18 gauge G90 galvanized steel with a factory baked enamel finish. The finish and hardware shall be tested in accordance with ASTM B117 salt spray test for a minimum of 500 hours. Unit frame shall be heavy gauge with lifting holes/fork lift slots.

3. Compressor(s) shall be isolator mounted, high efficient, hermetically sealed, refrigerant cooled, reciprocating or scroll type with high starting torque. Motor shall be capable of operating at plus/minus 10 percent of nameplate voltage. Motor shall have internal temperature and current sensors for motor protection. Unit shall have multiple compressors, an inverter type that enables a speed change based on the measured suction gas temperature and a second non-inverter type. Each compressor shall have a crankcase heater, an automatic resetting low pressure safety, a manual reset high pressure safety, and an internal thermal overload protector. Oil separators and an oil management system shall be provided with the unit.
 4. Condenser coils shall be 3/8" smooth bore copper tubes with aluminum fins mechanically bonded to the tubes. Fins shall not be spaced closer than 12 fins per inch. The coil shall be factory-treated for corrosion protection. Provide subcooling circuits integral with the condenser coils for a minimum of 10°F subcooling. Coils shall be factory pressure tested to 425 psig. PVC coated metal coils guards shall be factory installed for coil protection. Coil guards shall be a minimum of 20 ga. galvanized steel louver type to protect the coil from hail or other damage, wireguards are not acceptable.
 5. Condenser fan(s) shall be aluminum or galvanized steel blades with non-corrosive hubs and a fan guard. Fan motors shall be direct drive, totally enclosed, permanent split capacitor type, permanently lubricated bearings, with built-in thermal overload protection.
 6. Condensing units shall be completely factory wired with terminal block connections for all customer wiring interfaces. Units shall have a non-fused single point power disconnect switch and a factory installed, wired, and fused 24 volt control power transformer. Factory controls shall include: (1) anti-short circuit time delay relay(s), (2) low ambient temperature start-up and control down to 0°F, (3) pump down cycle, (4) coil frost control and defrost heating, (5) refrigerant auto-charging function, (6) refrigerant charge checking function, (7) defrost heating, (8) VFD Compressor Inverter control, (9) self-diagnostics, (10) auto-restart after power failure, (11) and oil recovery control.
 7. Condensing units shall be selected to operate in the range of 25-105°F ambient for cooling and 0-75°F for heating.
- D. All refrigerant piping connections shall be brazed with dry nitrogen. Mechanical fittings are not allowed. Pressure test with dry nitrogen at 600 psi for 24 hours. Triple evacuate to <500 microns and hold for 1 hour.
- E. CONTROLS
1. Compressor inverter control: the inverter compressor speed shall be controlled based on the measurement of suction gas temperature. If the inverter is running at full load and the suction gas temperature is still in deficit, the second, non-inverter compressor shall be commanded on. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value.
 2. Auto restart: The system shall automatically restart operation after a power failure without programming losses. In the event of compressor failure the remaining compressor shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity.
 3. Auto Charge Feature: The unit shall incorporate an auto-charging feature and a refrigerant charge check function.

4. Safeties: The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
5. Oil Recovery Cycle Control: Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.
6. Low Ambient & Defrost Heating: The outdoor unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls. The system shall continue to provide heat to the indoor units while in the defrost mode.
7. Provide master controller that is BACnet compatible to allow integration into the Building Automation System. Master controller shall allow setback scheduling and temperature set points changes via the BAS.
8. Individual Zone Controller: Furnish an individual zone controller with each fan coil unit with the following functions/features:
 - a. A self diagnosis function that constantly monitors the system for malfunctions.
 - b. Display of fault locations and conditions.
 - c. An LCD digital display that allows the temperature to be set in 1°F units.
 - d. A thermostat sensor in the remote controller.
 - e. Ability to select cool / heat / fan operation mode with indoor remote controller.
 - f. Built in 7 Day Timer functionality with up to 5 timer actions per day
 - g. Approximately two hour battery backup
 - h. The following programming functions shall be provided:

OPERATION	Start/Stop
	Operation Mode
	Temperature Setting
	60°F – 90°F Set Point Range
	Fan Speed
	Airflow Direction
MONITORING	Status
	Malfunction Flashing
	Malfunction Content
	Filter Sign
	Operation Mode
	Temperature Setting
	Permit/Prohibit
	Fan Speed
SCHEDULING	Airflow Direction
	7-Day Time Clock
	5-Temp Settings (Actions) per day
	Away Temp Set-Back Function
CONTROL MANAGEMENT	Field Setting Mode
	Group Setting
	Min & Max Temperature Setting
	Auto Re-start

- F. Power wiring and refrigerant piping shall be installed per the manufacturer's installation guidelines.

- G. After initial start-up visit, manufacturer's startup technician shall be available to meet the temperature control's technician on site to verify all mapped points are accessible and controllable (via the onboard controller BACnet interface) as required to meet the Sequence of Operations.
- H. WARRANTY
1. The units shall have a manufacturer's warranty period of one (2) year from date of substantial completion and start-up. The units should have a limited labor warranty for a period of one (1) year from date of start-up. The compressors shall have a warranty of six (6) years from date of substantial completion. During the stated period, should any part fail due to defects or material and workmanship, it shall be repaired or replaced by a factory trained service professional.

2.4 CONDENSING UNITS

- A. Condensing units shall be U.L. Listed, fully assembled, piped, and wired packaged units, shipped as one piece, which are a current production line and fully cataloged by the manufacturer. Unit shall be shipped with a full refrigerant and oil charge.
- B. Unit casing shall be removable service panels constructed of a minimum 18 gauge G90 galvanized steel with a factory baked enamel finish. The finish and hardware shall be tested in accordance with ASTM B117 salt spray test for a minimum of 500 hours. Unit frame shall be heavy gauge with lifting holes/fork lift slots.
- C. Compressor shall be isolator mounted, high efficient, hermetically sealed, refrigerant cooled, reciprocating or scroll type with high starting torque. Motor shall be capable of operating at plus/minus 10 percent of nameplate voltage. Motor shall have internal temperature and current sensors for motor protection. Units larger than 7 tons shall have multiple compressors with a minimum of two stages of control. Each compressor shall have separate refrigeration circuits each with a thermostatic expansion valve. Each compressor shall have an automatic resetting low pressure safety and a manual reset high pressure safety. Refrigeration filter-drier, sight glass, liquid service valve, suction service valve, and gauge ports shall be factory furnished and installed.
- D. Condenser coils shall be 3/8" smooth bore copper tubes with aluminum fins mechanically bonded to the tubes. Fins shall not be spaced closer than 12 fins per inch. Provide subcooling circuits integral with the condenser coils for a minimum of 10°F subcooling. Coils shall be factory pressure tested to 425 psig. [PVC coated metal coils guards shall be factory installed for coil protection]. [Coil guards shall be a minimum of 20 ga. galvanized steel louver type to protect the coil from hail or other damage, wireguards are not acceptable.] Condenser fan(s) shall be aluminum or galvanized steel blades with non-corrosive hubs. Fan motors shall be direct connected, totally enclosed, permanent split capacitor type, with built-in thermal overload protection.
- E. Condensing units shall be completely factory wired with terminal block connections for all customer wiring interfaces. Units shall have a non-fused single point power disconnect switch and a factory installed, wired, and fused 24 volt control power transformer. Factory controls shall include: anti-short circuit time delay relay(s), low ambient temperature start-up and control down to 140°F [0°F], pump down cycle, and coil frost control. [The units will have field

installed hot gas bypass valves (furnished by mechanical contractor) with the discharge piped after the thermal expansion valve and before the evaporator.]

- F. Units shall have a complete one year warranty and a five year warranty on the compressor.
- G. Condensing units shall be selected at 105°F ambient.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Furnish and install units of the configuration, size, and capacities as indicated on the drawings.
- B. Split-system Air Conditioners
 - 1. Install units level and plumb.
 - 2. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
 - 3. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
 - 4. Equipment Mounting:
 - a. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s).
 - 5. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- C. Condensing Units
 - 1. Install units level and plumb, firmly anchored in locations indicated.
 - 2. Install roof-mounting units on equipment supports.
 - 3. Install grade-level units on cast-in-place concrete equipment bases.
 - 4. Maintain manufacturer's recommended clearances for service and maintenance.
 - 5. Loose Components: Install piping specialties, electrical components, devices, and accessories that are not factory mounted.

END OF SECTION 23 84 00

SECTION 23 82 00 – CONVECTION HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Variable volume terminal unit
 - 2. Duct-mounted hot water reheat coils
 - 3. Fan-coil units
 - 4. Hot water unit heaters
 - 5. Electric unit heaters
 - 6. Convectors
 - 7. Fin-tube radiation
 - 8. Commercial Panel Radiators
 - 9. Terminal unit coil hookup

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Variable volume terminal unit
 - 1. Anemostat

2. Carnes
 3. Carrier
 4. Enviro-Tech
 5. JCI
 6. Krueger
 7. Metal Aire
 8. Nailor
 9. Price
 10. Titus
 11. Trane
- B. Duct-mounted hot water reheat coils
1. Daikin
 2. Heatcraft
 3. Marlo
 4. Precision Coil
 5. Super Radiator Coils
 6. Technical Systems
 7. Temtrol
 8. Trane
 9. USA Coil
 10. Approved equivalent
- C. Fan Powered Terminal Units
1. Anemostat
 2. Carnes
 3. Carrier
 4. Enviro-Tech
 5. JCI
 6. Krueger
 7. Metal Aire
 8. Nailor
 9. Price
 10. Titus
 11. Trane
 - 12.
- D. Fan-coil units
1. Airtherm
 2. Daikin
 3. Engineered Air
 4. Enviro-tec
 5. JCI
 6. Trane
 7. Approved equivalent
- E. Hot water unit heaters
1. Airtherm
 2. Daikin
 3. Engineered Air

4. Enviro-tec
 5. JCI
 6. Rittling
 7. Trane
 8. Approved equivalent
- F. Electric unit heaters
1. Indeeco
 2. Marley
 3. Modine
 4. QMark
 5. Reznor
 6. Trane
- G. Convectors
1. Daikin
 2. Sterling
 3. Rittling
 4. Trane
 5. Vulcan
 6. Approved equivalent
- H. Fin-tube radiation
1. Sterling
 2. Rittling
 3. Trane
 4. Vulcan
- I. Commercial Panel Radiators
1. Rittling
 2. Runtal
 3. Vulcan
- J. Air Curtain
1. Mars or approved equivalent
- K. Terminal unit coil hookup
1. Valves
 - a. Apollo 7B-100
 - b. Cimberio 630B, 200MC
 - c. Webstone T-drain, Ball Drain
 - d. Approved equivalent
 2. Hoses
 - a. ACE Hose
 - b. Chamflex
 - c. Hosecraft USA
 - d. Twin City Hose
 - e. Approved equivalent

2.3 VARIABLE VOLUME TERMINAL UNIT WITH HOT WATER [ELECTRIC] HEAT

- A. Unit casing shall be welded, galvanized steel. Leak rate shall be not more than 1% of rated capacity at 4" wg. Interior surface of unit casing shall be acoustically and thermally lined with 1/2 inch thick, minimum of 1.5 lb./cu. ft. density glass fiber with [high density facing] [foil face]. Insulation shall be UL listed and meets NFPA-90A and UL 181. Factory mounted, removable panel on bottom of unit providing access to air valve and entering airside of coil. Straight flange or slip and drive rectangular discharge duct connection.
- B. Air valve shall be a 90° rotational damper flow control device with factory installed direct digital controls (DDC). All controls shall be furnished under Division [25] [171000] and mounted and wired in the factory by unit manufacturer. Manufacturer shall provide multiple point averaging flow sensing ring with high and low pressure pneumatic tubes compatible with DDC velocity pressure sensor. A calibration chart shall be provided on each unit.
- C. At the Contractor's option Division [25] [171000] may field mount controls at no additional cost to the Owner.
- D. [Factory mounted one or two water row coil with maximum of 12 fins per inch. Full fin collars for accurate fin spacing and maximum tube-fin contact, 5/8 inch O.D. seamless copper tubes mechanically expanded into the fin collars, leak tested at 300 psig.]
- E. [Factory mounted electric coil]
 - 1. Line terminal block
 - 2. Control terminal block
 - 3. Nickel chrome heating element
 - 4. ETL listed
 - 5. Differential pressure airflow switch
 - 6. Safeties
 - a. Primary automatic reset thermal cutout
 - b. Secondary manual reset thermal cutout
 - 7. [SCR controller]

2.4 DUCT MOUNTED HOT WATER REHEAT COILS

- A. Hot water reheat coil casings shall be galvanized steel. Coils shall be constructed with no less than 1/2" diameter x .020" wall thickness copper tubes and .0075" aluminum or copper fins spaced not closer than indicated on equipment schedule. Fins shall be permanently secured to the tubes by mechanical bonding or soldering and shall be plate type. Frame shall include intermediate tube supports to prevent sagging of the tubes.
- B. Headers and "U" bends shall be arranged so that the entrained air is carried along with the flow of water through the coil to the high point on the leaving water header. High points in the coil shall be provided with vent connections. Multi-row coils shall be arranged for counterflow heat exchange between the air and water.
- C. Coils performance shall be AHRI 410 certified. Submittals shall include AHRI certified reference number.

2.5 DUCT MOUNTED ELECTRIC REHEAT COILS

- A. Elements shall be made of high quality alloy resistor wire, centered and permanently encased with highly compacted, rockhard refractory material, surrounded by steel sheath. Helical fins shall be furnace brazed to the sheath for rapid heat transfer. Sheath and fins shall be coated with a high temperature fired ceramic for corrosion resistance
- B. Units shall have primary over temperature protection, secondary over temperature protection, and overcurrent protection all mounted in an enclosed control cabinet mounted on the units.

2.6 PARALLEL FAN POWERED UNIT WITH HOT WATER HEAT

- A. Unit casing shall be welded, galvanized steel. Leak rate shall be not more than 1% of rated capacity at 4" wg. Interior surface of unit casing shall be acoustically and thermally lined with 1 inch thick, minimum of 1.5 lb./cu. ft. density glass fiber with foil face. Insulation shall be UL listed and meets NFPA-90A and UL 181. Factory mounted, removable panel on bottom of unit providing access to air valve and entering airside of coil. Straight flange or slip and drive rectangular discharge duct connection. Provide hanger bracket.
- B. Factory mounted one or two row coil with maximum of 12 fins per inch. Full fin collars for accurate fin spacing and maximum tube-fin contact, 5/8 inch O.D. seamless copper tubes mechanically expanded into the fin collars, leak tested at 300 psig.
- C. Air valve shall be a 90° rotational damper flow control device with factory installed direct digital controls (DDC). All controls shall be furnished under Division 25 and mounted and wired in the factory by unit manufacturer. Manufacturer shall provide multiple point averaging flow sensing ring with high and low pressure pneumatic tubes compatible with DDC velocity pressure sensor. A calibration chart shall be provided on each unit.
- D. ECM fan motor shall be designed for high-efficient operation with over 70% efficiency throughout the operation range.
- E. Provide 1" filter on the plenum inlet which attaches to the unit with a frame filter.
- F. At the Contractor's option Division 25 may field mount controls at no additional cost to the Owner.

2.7 FAN COIL UNITS

- A. The basic unit shall be constructed of galvanized steel and insulated to meet the ARI Fan-Coil Industry test standard for insulation efficiency. Coils, motor speed control, electric junction box, primary and auxiliary drain pans, motor board, motor(s), and fan(s) shall be included in the basic unit.
 - 1. Exposed wiring shall be in flexible conduit. Unit mounted electrical devices shall be prewired to a junction box. Units shall comply with Underwriters' Laboratories standard No. 883 for Room Fan Coil Units. All unit/cabinet styles: shall have a factory installed and wired disconnect switch. Disconnect switch shall be Hubbell model HBL-1221 or equivalent.

2. Unit shall have an externally insulated stainless steel condensate drain pan/trough. An auxiliary drain pan located in end pocket shall be molded plastic. Drain surfaces shall be separate from the motor board assembly.
 3. Insulation shall be 1/2" thick, 2 lb. density, foil faced fiberglass with no exposed fiberglass to the air stream.
 4. Motors and fans shall be mounted on a removable galvanized steel motor board assembly. Wiring shall have a modular plug to allow removal of the motor board from the unit without tools.
 5. Fan wheels shall be metal centrifugal forward curve type, dynamically balanced. Fan housing shall be constructed of galvanized steel with streamlined air inlets.
- B. Coils
1. Cooling coils shall be constructed of 1/2" O.D. seamless copper tubes mechanically bonded to aluminum fins. The entire coil assembly shall be factory tested with 300 psig air pressure when the coil is submerged in warm water. It shall have a maximum working pressure of 200 psig. Each coil shall be provided with a manual air vent.
 2. Auxiliary heating coils shall be constructed of 1/2" O.D. seamless copper tubes mechanically bonded to aluminum fins. The coils shall be tested at 300 psig air pressure under warm water, and shall have a maximum working pressure of 200 psig. Each coil shall be provided with a manual air vent.
- C. Motors shall be resilient mounted, permanent split capacitor, totally enclosed, tap wound for 3-speed, with integral thermal overload protection and automatic reset. Minimum power factor shall be .96. Motors shall be permanently lubricated with provision for re-oiling. High static motors shall be provided as scheduled or as need to meet the scheduled performance.
- D. Exposed floor mounted cabinets:
1. Cabinets shall be constructed with 16 gauge steel fronts, tops, and end panels. Cabinet shall have 18 gauge back panel. Fronts, backs, sides, and top panels forming the air flow path shall be insulated for maximum thermal and acoustical performance. Cabinet parts shall be cleaned and phosphatized before painting.
 2. Cabinets shall have extended 9" end pockets on both sides. [Top panels shall be provided with two die-formed flush, hinged access doors to access thermostat.] [Top panel shall not have access doors.]
 3. Front panels shall be one piece, tamper proof, secured to the unit without visible fasteners. Units shall have four leveling bolts.
 4. The finish shall be baked enamel with color selected by Architect, from the manufacturer's standard colors.
 5. [Units shall have stamped steel supply grille.]
 6. [Units shall have 4-way double deflection, steel painted to match the unit supply grill.]
 7. [Units shall have 4-way double deflection, clear anodized aluminum supply grill.]
 8. [Factory Controls: Factory furnished and wired, unit mounted thermostat/controller with integral fan speed and sequenced heating and cooling. Furnish, install, and wire electric modulating control valves.]
- E. Exposed horizontal cabinets and Ceiling Recessed Units:
1. Cabinets shall be constructed with 16 gauge steel panels. Fronts, backs, sides, and top panels forming the air flow path shall be insulated for maximum thermal and acoustical performance. Cabinet parts shall be cleaned and phosphatized before painting.

2. The finish shall be baked enamel with color selected by Architect, from the manufacturer's standard colors.
3. Cabinets shall have extended 9" end pockets on both sides. Bottom panels shall be one piece, hinged, with tamper proof fasteners.
4. Units shall have stamped angled louvers, both for inlet and outlet.
5. [Factory Controls: Factory furnished, field installed, remote mounted thermostat/controller with integral fan speed, automatic change over and sequenced heating and cooling for modulating control valves.]

F. Concealed Units

1. Casing shall be constructed of 18 gauge panels. Units shall be furnished with inlet and outlet duct collars, and vibration isolation grommets.
2. [Factory Controls: Factory furnished, field installed, remote mounted thermostat/controller with integral fan speed, automatic change over and sequenced heating and cooling for modulating control valves.]
3. Wall Recessed Units:
4. Cabinets shall have a one-piece 16-ga. steel front panel with stamped angled louvers, both for inlet and outlet. Cabinet shall be galvanized front and back with baked enamel finish in a color chosen by the Architect. Cabinet shall be airtight at all seams including wall to unit seal to prevent smudging. Cabinet shall be provided with tamper proof access panels.
5. [Factory Controls: Factory furnished and wired, unit mounted thermostat/controller with integral fan speed and sequenced heating and cooling. Furnish, install, and wire electric modulating control valves.]
6. Filters shall be 1" pleated fiberglass media 30% (MERV 7) throw-away filters. Furnish and install one complete set of filters for start-up and one complete set of filters following substantial completion and acceptance.

G. Factory Valve Package:

1. [None]
2. [Furnish factory furnished and installed soldered joint copper piping package consisting of the following for each coil: Supply – isolation ball valve, P/T access plug. Return – manual circuit setter with memory stop, 2-way electric modulating control valve (NC for cooling, NO for heating), P/T access plug. A drain valve shall be installed at the low point of the piping. Piping components shall be located so that there is proper maintenance access (i.e. must be able to attach access fitting and hose to circuit setter and P/T fittings, can remove/replace control valve actuator, can operate valves) with disturbing any piping.

2.8 HOT WATER UNIT HEATERS

- A. Cabinet type units shall include a 16 gauge furniture steel casing, inclined blade type inlet and discharge grilles, removable panels, 120/1/60 fan motors, quiet operating centrifugal fans, non-ferrous hot water heating coils, throwaway filters, vandal proof fasteners, and air vent tappings. The heaters shall be arranged for mounting as indicated. Heater casings shall be finished in baked enamel with colors as selected by the Architect/Engineer.
- B. Propeller type units shall have a heavy gauge enameled steel casing, deep pitch propeller fan direct connected to a resiliently mounted capacitor start squirrel cage induction motor 120/1/60,

adjustable discharge louvers, fan guard, non-ferrous hot water heating coil with supply and return connection in rear of unit, arranged for hanging from top side hanger rod connections, and finished in the manufacturer's standard color baked enamel finish.

2.9 ELECTRIC UNIT HEATERS

- A. Cabinet type units shall include a 16 gauge furniture steel casing, inclined blade type inlet and discharge grilles, removable panels, 120/1/60 fan motors, quiet operating centrifugal fans, nickel chrome heating coils, throwaway filters, vandal proof fasteners, and air vent tappings. The heaters shall be arranged for mounting as indicated. Heater casings shall be finished in baked enamel with colors as selected by the Architect/Engineer.
- B. Propeller type units shall have a heavy gauge enameled steel casing, deep pitch propeller fan direct connected to a resiliently mounted capacitor start squirrel cage induction motor 120/1/60, adjustable discharge louvers, fan guard, nickel chrome heating coil with supply and return connection in rear of unit, arranged for hanging from top side hanger rod connections, and finished in the manufacturer's standard color baked enamel finish.
- C. Unit shall be provided with safety thermal cutouts, fan delay control relay, and built-in thermostat, remote wall thermostat or BAS connection as scheduled.

2.10 CONVECTORS

- A. Convector elements shall be constructed of copper tubes expanded and rolled into cast iron headers with contact further strengthened by brass bushings, aluminum fins, ribbed steel side plates and fin tube supports. Fins shall have integral fin collars which space the fins and provide fin-to-tube surface firmly bonded to the tube by mechanical expansion of the tube to ensure durability, eliminate noise from loose fins and ensure performance at cataloged ratings. End supports shall carry weight of element and be designed to fit over header to provide completely free area from tubes to header. No solder or welded joints or compression couplings shall be permitted. All elements shall withstand 100-pound air pressure factory tested under water.
- B. Wall Hung Units:
 - 1. Cabinet front and top panels shall be 16-gauge steel. End panels shall be no less than reinforced 18 gauge. A horizontal channel stiffener shall be on the inside of all front panels. Cabinet backs shall be phosphatized, galvanized; front, top and sides shall be phosphatized and painted inside and out with one coat of gray primer. Fronts shall be secured in place by quick opening front panel fasteners or camlock fasteners. A roll-formed channel section that also permits hinged type mounting of the cabinet front panel for easy access shall provide cabinet top line rigidity. Access doors are not required with this construction. Baked enamel finish shall be provided in standard manufacturer's colors as selected by the Architect..
- C. Recessed Units:
 - 1. Cabinets shall have a one-piece 14-ga. steel panel with stamped angled louvers, both for inlet and outlet. Cabinet shall be galvanized front and back with baked enamel finish in a color chosen by the Architect. Cabinet shall be airtight at all seams including wall to unit

seal to prevent smudging. Cabinet shall be provided with tamper proof access panels. Units shall be Trane, Vulcan, Sterling, or approved equal.

2.11 FIN TUBE RADIATION

- A. [Heating elements shall be copper tube with full hard temper aluminum fins 0.016" thick. All heating capacities shall be I-B-R certified.]
- B. [Heating elements shall be nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded to fins, with high-temperature cutout and sensor running the full length of the element. Element supports shall eliminate thermal expansion noise.]
- C. Enclosure shall be 16 gauge galvanized steel with 20 gauge galvanized steel partial back plate. Color shall be [selected from manufacturer's standard colors, custom color match]. Finish shall be baked enamel power coat. Extruded grilles shall be clear anodized finish and pencil-proof spacing. Furnish all necessary mitered corners, end caps, access doors, column covers, and accessories required for flush butting joints.
- D. Low profile, wall mounted, open bottom, architectural type shall have a maximum enclosure height of 7" (10" installed height) with extruded aluminum outlet grille.
- E. Low profile, wall mounted, stamped inlet grille, architectural type shall have a maximum enclosure height of 10" (10" installed height) with extruded aluminum outlet grille.
- F. Low profile, pedestal mount, open bottom, architectural type shall have a maximum enclosure height of 7" (10" installed height) with extruded aluminum outlet grille.
- G. Ultra-low profile, wall mounted, extruded inlet grille, architectural type shall have a maximum enclosure height of 6" (6" installed height) with extruded aluminum outlet and inlet grilles.

2.12 COMMERCIAL PANEL RADIATORS

- A. [Heating elements shall be steel, welded and formed into flat, square, steel header with minimum thickness of 0.109 inch. Include threaded piping and air-vent connections.]
- B. [Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded to fins, with high-temperature cutout and sensor running the full length of the element. Element supports shall eliminate thermal expansion noise.]
- C. Mounting: [Wall brackets] [Floor pedestals] with maximum spacing of 36 inches (914 mm).
- D. Finish: Baked-enamel finish in manufacturer's [standard] [custom] color as selected by Architect.
- E. Accessories:
 - 1. Steel piping covers finished to match radiator finish.

2.13 AIR CURTAIN

- A. Unit casing shall be one-piece constructed of galvanized steel. The unit shall be provided with integral discharge nozzle and washable aluminum mesh 1/4 inch filters.
- B. Motor shall be totally enclosed air over cooled motor with sealed lifetime pre-lubricated ball bearings, motor starter and thermal overload protection. Motor shall be wired for single speed operation. Fan shall be forward curved centrifugal type and the assembly shall be statically and dynamically balanced.
- C. Provide door-activated limit switch to be field installed.
- D. Units shall be as manufactured by Mars or approved equivalent.

2.14 TERMINAL COIL HOOKUP

- A. Contractor to provide valves and specialties specified herein and in section 20 10 13 Valves (not valves from a HVAC hose kit manufacturer). Two service valves and a manual balance valve are required regardless of memory function of balance valves.
- B. One of the following piping and specialty configurations is acceptable (piping components installed in the order listed):
 - 1. Supply service valve, balance valve, tee with integral drain, hard pipe or hose to coil, hard pipe or hose from the coil, tee with integral vent, control valve, service valve.
 - 2. Supply service valve with integral drain (on coil side), balance valve, hard pipe or hose to coil, hard pipe or hose from the coil, control valve, service valve with integral vent (on coil side).
- C. When hoses are used at the contractor's option they shall meet the following:
 - 1. Internal diameter of the hose shall be not less than 90% of the ID of copper pipe, for the pipe size on the drawings feeding the unit. Hose inner liner shall be EDPM rubber and shall be covered with stainless steel braid. Pressure rating shall not be less than 200 psig.
 - 2. Hoses shall have one fixed end male NPT connection and one swivel end. The swivel shall be a gasket-less JIC 37°F flared female connection, with companion flare x NPT fitting. Connections shall be stainless steel or brass. Hose kits shall be 24" long. Hoses using gaskets or o-rings are not acceptable.
- D. Specialty Valves incorporating auxiliary ports for p/t, drain, vent, etc. may be utilized provided the arrangement meets the flow diagram and the products do not contain unions, gaskets, or o-rings. Valves shall be dezincification resistant brass and shall be rated for 200psig minimum at 200°F.
 - 1. Service valve with integral drain /vent.
 - 2. Service valve with NPT tapping, plus separate drain cocks.
 - 3. Tee with integral drain /vent.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive **radiators** for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine ducts, plenums, and casings to receive **air coils** for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- C. Examine roughing-in for hydronic-piping and electrical connections to verify actual locations before installation of terminal units.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Variable volume terminal units
 - 1. Furnish and install terminal units of the size and capacities as indicated on the drawings.
 - 2. Install air terminal units according to NFPA 90A.
 - 3. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
 - 4. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.
 - 5. See piping details for required valves and accessories.
- B. Duct mounted hot water reheat coils
 - 1. Furnish and install duct heaters of the size and capacities as indicated on the drawings.
 - 2. Install coils level and plumb.
 - 3. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
 - 4. Straighten bent fins on air coils.
 - 5. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.
 - 6. Install piping adjacent to coils to allow service and maintenance.
 - 7. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping.
- C. Duct-mounted electric reheat coils
 - 1. Furnish and install duct heaters of the size and capacities as indicated on the drawings.
 - 2. Install coils level and plumb.
 - 3. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
 - 4. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.
 - 5. Connect wiring and ground equipment per Division 26.
 - 6. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

7. Install control and electrical power wiring to field-mounted control devices.
- D. Fan coil units and unit heaters
1. Furnish and install fan coil units and unit heaters of types, arrangements, and capacities as indicated on the drawings.
 2. Install units to comply with NFPA 90A.
 3. Install units level and plumb.
 4. Suspend units from structure with all-thread hanger rods and [elastomeric hangers] [spring hangers] [spring hangers with vertical-limit stop].
 5. Install wall-mounted thermostats and switch controls in electrical outlet boxes. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
 6. Install new filters in each unit within two weeks after Substantial Completion.
- E. Convectors
1. Furnish and install convectors of types, arrangements, and capacities as indicated on the drawings.
 2. Install convectors level and plumb.
 3. Install valves within reach of access door provided in enclosure.
 4. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.
 5. Install piping within pedestals for freestanding units.
- F. Fin tube radiation
1. Contractor shall furnish and install radiators of types, arrangements, lengths, and heating capacities as indicated on the drawings. Where the element length is less than cover length the Contractor shall install pipe, of the same material and size, between the elements. Verify the intent with the Engineer to space the elements evenly, or centered on the windows.
 2. Install units level and plumb.
 3. Install enclosure continuously around corners, using outside and inside corner fittings.
 4. Join sections with splice plates and filler pieces to provide continuous enclosure.
 5. Install access doors for access to valves.
 6. Install enclosure continuously from wall to wall.
 7. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.
 8. Install valves within reach of access door provided in enclosure.
 9. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.
 10. Install piping within pedestals for freestanding units.
- G. Commercial Panel Radiators
1. Contractor shall furnish and install lengths and heating capacities as indicated on the drawings. Where the element length is less than cover length the Contractor shall install pipe, of the same material and size, between the elements. Verify the intent with the Engineer to space the elements evenly, or centered on the windows.
 2. Install units level and plumb.
 3. Install piping covers

END OF SECTION 23 82 00

SECTION 23 83 00 – RADIANT HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: List
- B. Furnish and install

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A.

2.3 RADIANT HEATING ELECTRIC PANELS

2.4 RADIANT HEATING AND COOLING PIPING

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing conditions....

3.2 INSTALLATION

- A. Provide

3.3 CLEANING AND PROTECTION

- A. Clean

END OF SECTION 23 83 00

SECTION 24 00 00 – AIR DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provisions and conditions cited in this Section shall apply to Work for other sections of Divisions 24 of these Specifications.
- C. The following sections of the Specifications apply to Work under this Section
 - 1. Division 20 - Basic Mechanical Conditions and Basic Mechanical Material and Methods
 - 2. Division 23 – HVAC Piping and Equipment
 - 3. Division 25 – Temperature Controls

1.2 SUMMARY

- A. Section Includes:
 - 1. Sheetmetal ducts, sheet metal plenums, duct linings, flexible ductwork, dampers, and accessories.
 - 2. Air Devices, including adjusting the pattern controllers.
 - 3. Louvers and louvered penthouses.
 - 4. Installation of all mentioned above.
 - 5. Smoke stopping of all penetrations of ductwork and firestopping through fire rated partitions as shown on architectural drawing.
 - a. Stairways
 - b. Shafts
 - c. Corridors
 - d. Floors
 - e. Roofs
 - f. Required Exits (see Division 20)
- B. Related Requirements:
 - 1. Work for this section of the specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Division 20 in addition to the following:
 - a. ASHRAE, “Handbook 1997 Fundamentals”; Chapter 32 - Duct Design.
 - b. ASHRAE, “Handbook 1996 Equipment”; Chapter 16 - Duct Construction.
 - c. ASTM A90-81 (1991), “Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles”.
 - d. ASTM A525-91b, “Spec for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process”.
 - e. ASTM A527/A527M-90, “Spec for Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality”.
 - f. NFPA 90A, “Installation of Air Conditioning and Ventilating Systems.”

- g. SMACNA "HVAC Duct Construction Standard – Metal and Flexible" – Second Edition.
- h. UL 33, "Heat Responsive Links for Fire Protection Service."
- i. UL 555, "Fire Dampers and Ceiling Dampers."
- j. UL 181, "Factory Made Air Ducts and Connectors."

C. Definitions

- 1. The size of the ducts shown on the drawings and in this Section of the Specifications shall be the outside dimension of the ductwork which will take into account any internal acoustical lining thickness specified for duct system or sub-system.
- 2. The term "supply air" where used in this Section of the Specifications shall mean downstream of a coil.
- 3. The term "outdoor air" where used in this Section of the Specifications shall mean ambient air that has not been conditioned.
- 4. The term "return air" where used in this Section of the Specifications shall mean conditioned air that is returned from the space.
- 5. The term "mixed air" where used in this Section of the Specifications shall mean air streams that are a mixture of "outdoor air" and "return air".
- 6. The term "relief air" where used in this Section of the Specifications shall mean excess return air that relieved from the building.
- 7. The term "exhaust air" where used in this Section of the Specifications shall mean air that is removed due to contaminants, odors, or heat.

1.3 QUALITY ASSURANCE

- A. Installation manual: For each type of product.

1.4 ACTION SUBMITTALS

- A. Refer to General Conditions and Division 20

1.5 CLOSEOUT SUBMITTALS

- A. Refer to General Conditions and Division 20

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 24 00 00

SECTION 24 31 00 – SHEETMETAL DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings
 - 2. Double-wall rectangular ducts and fittings.
 - 3. Single-wall round ducts and fittings.
 - 4. Double-wall round ducts and fittings.
 - 5. Sheet metal materials.
 - 6. Duct liner.
 - 7. Sealants and gaskets.
 - 8. Hangers and supports.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Refer to Division 20 for seismic delegated design requirements.

2.2 MANUFACTURERS

- A. Listed grease ducts:
 - 1. Captiveaire
 - 2. Duravent
 - 3. Selkirk
 - 4. Thermotech

2.3 MATERIAL

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, unless otherwise indicated. Sheet metal materials are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel:
 - 1. Comply with ASTM A653/A653M.
 - 2. Galvanized Coating Designation: G90.
 - 3. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. PVC-Coated, Galvanized Sheet Steel:
 - 1. Comply with ASTM A653/A653M.
 - 2. Galvanized Coating Designation: G90.
 - 3. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil thick on opposite surface.
 - 4. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.
- D. Carbon-Steel Sheets:
 - 1. Comply with ASTM A1008/A1008M.
 - 2. Oiled, matte finish for exposed ducts.
- E. Stainless Steel Sheets:
 - 1. Comply with ASTM A480/A480M, Type 304 or 316, as indicated in "Duct Schedule" Article.
 - 2. Cold rolled, annealed, sheet.
 - 3. Exposed surface finish is to be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.
- F. Aluminum Sheets:
 - 1. Comply with ASTM B209 (ASTM B209M) Alloy 3003, H14 temper.
 - 2. Mill finish for concealed ducts.
 - 3. Standard, one-side bright finish for duct surfaces exposed to view.

2.4 CONSTRUCTION

- A. General Construction Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for material thicknesses, and construction methods unless otherwise indicated.
 - 1. Where local code requires gauges heavier than required by SMACNA then the local code shall govern.
- B. All rectangular ducts unless specified otherwise shall be "Pittsburgh Lock" longitudinal joints. Snaplock is not acceptable.
- C. All round ducts and flat oval ducts shall have spiral seams or continuously welded longitudinal seams.
 - 1. Round ductwork where scheduled or where indicated on the plans shall be K-27 double wall internally insulated for sound control and/or thermal performance.
- D. All transverse joints in rectangular ductwork 24" and larger shall be Ductmate, SMACNA T-25, or approved equivalent. All flanged ductwork, regardless of pressure class, shall use gaskets, corner closures, and be TEK screwed or riveted on 10" centers with a minimum of two (2) per side. Transverse joints in rectangular ductwork smaller than 24" shall be made in accordance with SMACNA suitable with the pressure class.
- E. All transverse joints in round and oval ductwork 24" and larger shall be Ductmate, or approved equivalent. Transverse joints in round and overall ductwork smaller than 24" shall be beaded sleeve joints.
- F. Panels in all ducts 12" and larger shall be cross-broken or beaded on 12" centers.
- G. Dust collection ductwork:
 - 1. Diameters 3" - 24" Quick-Fit pipe, adjustable nipples, and collars attached to other components will have one or both ends die formed-rolled to provide a uniform edge around the circumference of the rolled end. The pipe and adjustable nipples shall have the longitudinal seam laser welded to allow for a tighter slip joint and reduce system pressure losses. All laser welded seams will undergo a light test to ensure there are no voids or imperfections in the system. Pipe lengths using laser welded seams will not exceed a nominal 60" length. The rolled edges provide structural support at 5' intervals or less and can be interpreted as a stiffener where SMACNA specifications are required. An adjustable nipple is used for adjustment during the install process. Pipe is cut to appropriate length and the adjustable nipple secures the pipe for install.
 - 2. Quick-Fit pipe and components larger than 24" shall utilize either an angle flange or flat flange attached loosely and retained in place using a 3/8" Vanstone lip. The flanged pipe shall have a solid welded seam and not exceed nominal 60" length. The angle or flat flanges provide structural support at 5' intervals or less and are considered as stiffeners where SMACNA specifications are required.
 - 3. Ducting and its components shall be factory tested to +/- 80" WG on pipe diameters 3" to 20" and will use 22 gauge material thickness for 3" to 12" duct and 20 gauge for larger ducts.
 - 4. Rolled edge duct clamps shall be constructed with an over-center, spring-lever action for quick connecting of two pieces of ducting. A retaining pin shall be inserted in the handle

and an eyelet on the clamp as a safety feature to ensure the handle does not prematurely come undone.

5. Metal-to-metal contact shall be obtained at all joint connections. Die-formed rolled edges are uniform in shape to provide the most consistent contact. The ears of the clamp contact with the rolled edges and provide maximum conductivity. Conductivity shall be adhered to per NFPA 77 paragraph 8.4.1.1; states all parts of the continuous metal piping system should have a resistance level that does not exceed 10 ohms. Contractor shall field test resistivity.
6. Dust collection ductwork shall be Nordfab Quick-Fit pipe or approved equivalent. Layout shall be factory designed and submit as shop drawing

2.5 SEALING

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
- B. Sealing system components shall be water, mold and mildew resistant.
- C. Dust collection ductwork:
 1. Approved caulk is 3M Scotch Seal Metal Sealant 2084 or equivalent for system temperatures of 250°F or lower.
 2. Sealing O-rings shall be Buna-N, ASTM D2000 MBC610, 60 Durometer Hardness, with a temperature rating of 250°F maximum and is black in color, used with the adjustable nipple.
 3. Sealing gaskets shall be molded and shall meet the material classification of ASTM D-2000 M2BG510 A24 B34 EO14 EO34 EF11 EF21 and used in systems where the temperature rating is 225°F or less and are black in color. This component shall be made using conductive materials for conductivity.
 4. Sponge O-ring shall meet the material classification of either ASTM D-1056-68 – SBE43 or ASTM D1056-85, 91, 98 – 2B3
 5. Clamp seals shall be Nitrile to meet or exceed ASTM D1056 2B2 standards with a temperature rating not to exceed 158°F constant temperature (or intermittent temperature of 194°F).

2.6 FITTINGS

- A. Rectangular duct branch take-offs, or rectangular to round, shall be 45°-boot fittings, spin in fittings are not acceptable.
- B. Rectangular duct proportional splits shall be made the sizes as shown on the drawings. Where duct sizes are changed from the original design, Contractor shall proportion split equal to the split in airflow.
- C. Rectangular duct changes in direction:
 1. 90 degree elbows, refer to plans, shall be mitered with turning vanes; or radiused with centerline radius to width ratio of 0.75 (inside radius/width ratio 0.25 with curve ratio 0.585) with 2 splitter vanes.
 2. 45 degree and less elbows shall be mitered without vanes.

3. Elbows other than above shall be radiused with centerline radius to width ratio of 1 without splitter vanes.
- D. Round or Oval elbows and changes in direction shall have a minimum centerline radius of 1-1/2 that of duct size. Round or oval branch take-off shall be 45 degree booted style similar to McGill Airflow Lo-Loss Tee.
- E. Welding fume exhaust:
 1. Provide "Nordfab" long radius elbows fabricated from 22 gage galvanized steel. Long radius bolted replaceable elbows fabricated from 22 gage stainless steel are also acceptable.

2.7 PLENUMS

- A. Sheetmetal plenums shall be constructed of a minimum of 18 ga. or greater as determined by the pressure class of the plenum. Sheetmetal and shall be braced and reinforced to support the weight of a 200-lb. person. Tie rods shall not be used.
- B. Plenums shall be constructed without air turning vanes.
- C. Plenums shall have access doors as sized on drawings, where no size is shown provide a minimum size of 18" x 36". Comply with requirements in Section 243000 "Ductwork Accessories" for access door construction and installation requirements.

2.8 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct." Under no case will less than double thickness 1" x #24-gauge galvanized metal be allowed. Cable hangers are not allowed.
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
- E. Steel Cables for Stainless Steel Ducts: Stainless steel complying with ASTM A492.
- F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 2. Supports for Stainless Steel Ducts: Stainless steel shapes and plates.

3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.
- I. Listed grease duct supports shall be constructed from non-combustible material.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.
- B. All ductwork shall be neatly constructed, stiffened, on the outside surfaces where necessary to prevent perceptible vibration or buckling. All ducts, housings, etc., shall be fabricated as detailed on the drawings and in the SMACNA Duct Construction Manual –Latest Edition.
- C. All supply ductwork, unless specified otherwise, shall be constructed of gauges and reinforcement to 4" w.g. static pressure in SMACNA Duct Construction Standard – Latest Edition.
- D. All return, exhaust, outdoor air, relief, and supply ductwork downstream of terminal units shall be constructed of gauges and reinforcement to 2" w.g. static pressure in SMACNA Duct Construction Standard – Latest Edition. As a minimum, panels in all ducts 12" and larger shall be cross-broken or beaded on 12" centers.
- E. Install ducts in maximum practical lengths with fewest possible joints.
- F. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- G. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- J. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- K. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

- L. Install fire and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 243000 "Ductwork Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.
- M. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.
- N. When approved by the Engineer ducts may be notched at structural steel. The converging angle shall be no greater than 30°, the diverging angle shall be no greater than 15°.
- O. When approved by the Engineer objects may penetrate a duct. An airfoil shape shall be placed around the object to minimize turbulence.
- P. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.[Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."]

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 PATTERN HOLE DUCTWORK

- A. Install ducts in Supply air for the Black Box theater in the Art Annex building shall be distributed through low-velocity patterned hole ductwork. Locations of this type of ductwork are identified on the drawings.
- B. Patterned hole ductwork shall consist of an assembly of round spiral ductwork with field-installed 1" thick slide-in acoustic liner. Ductwork shall be paint grip galvanized finish in anticipation of field-applied painting. See section 24 31 00 for details about construction of the ductwork and section 24 33 50 for details about the acoustic duct liner.
- C. Procedure for assembly and installation of the patterned hole ductwork shall be as follows:
 - 1. Clean spiral ductwork. See section 24 00 08 for duct cleaning requirements.

2. Install duct liner in ductwork. Follow manufacturer's instructions for a standard install in round spiral ductwork.
3. Cut holes through ductwork and liner, with the pattern following that on the mechanical details sheet (three rows of 4" holes – one row running along the top of the duct and the other two rows running 45° off top center). Avoid ribs in ductwork to ensure structural stability. The self-applied radial pressure of the duct liner should allow it to be cut post-installation in the ductwork.
4. After the holes are cut, the ductwork shall again be thoroughly cleaned and vacuumed out to remove any dust particles.
5. Apply dark gray or black mastic sealant to cut surface of holes to prevent future fraying of duct liner.
6. Temporarily cover holes in ductwork using airtight covers.
7. Install ductwork. Ductwork shall not be used for temporary conditioning of the space for construction purposes.
8. Paint ductwork according to section 20 10 75 (dry-fall paint, black). Do not complete this step until the exterior walls of the building have been closed up, and dust has been removed from the space.
9. Remove hole covers and inspect ductwork for any necessary touch-ups.

3.4 DUCTWORK EXPOSED TO WEATHER

- A. All external joints are to [be welded] [have secure watertight mechanical connections]. Seal all openings to provide weatherproof construction.
- B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.
- C. Single Wall:
 1. Ductwork is to be [Type 304] [Type 316] stainless steel.
 2. Ductwork is to be aluminum.
 3. Ductwork is to be galvanized steel.
 4. Where ducts have external insulation, provide weatherproof aluminum jacket. See Section 230713 "Duct Insulation."

3.5 SEALING

- A. Duct sealant shall be flexible, water-based, adhesive sealant designed for use in 4" static pressure systems. Sealer shall be UL listed and conform to ASTM E84. Sealer shall be equal to Ductmate PROseal, United McGill Uni-Mastic, Duro-Dyne DSW, or equivalent.
- B. All supply ductwork unless specified otherwise shall be SMACNA's seal class A.
- C. All return, exhaust, outdoor air, relief and supply ductwork downstream of terminal units shall be SMACNA's seal class B.

3.6 SURFACE PREPARATION FOR PAINTED DUCTWORK

- A. Contractor shall inspect all exposed ductwork for damage, dents, and out of roundness. Replace all imperfect ductwork.
- B. Ductwork shall be sealed, tested (where applicable) and cleaned thoroughly prior to painting.
- C. Galvanized ductwork that is to be painted shall be installed with paintgrip galvanized finish.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Hangers Exposed to View: Threaded rod and angle.
- C. Ducts that are to be externally insulated shall not be supported on unistrut channel unless it required based upon loading. Hanger rods for trapeze bars shall be spaced to allow for insulation installation.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.8 DUCTWORK CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

3.10 CLEANING AND PROTECTION

- A. Contractor shall implement procedures to maintain an "Advanced Level" of ductwork cleanliness per the latest addition of the SMACNA Duct Cleanliness for New Construction Guidelines.
 - 1. Production and Site Delivery:
 - a. Self-adhesive labels for part of identification are to be applied to the external surfaces only.
 - b. During transportation, ductwork and air distribution components shall be sealed either by blanketing or capping the duct ends, bagging small fittings, surface wrapping or shrink wrapping.
 - 2. Site Storage:

- a. Temporary storage shall be located away from high dust generating processes such as masonry, tile cutters, saws, drywall sanding, mortar and plaster mixers, roof pitch kettles, portable electric generators, and main walkways that will be constantly broom swept.
 - b. Temporary storage shall include pallets or blocking to keep ductwork and air distribution components above floor surface to prevent water damage.
 - c. Coverage should be used to protect stored materials at all times.
 - d. Duct open ends and air side of air distribution components shall be securely sealed at all times.
 - e. Seals shall be visually examined and if damaged, resealed with an appropriate material.
3. Installation:
 - a. Before installation of individual duct sections and air distribution components, they are to be inspected to ensure that they are free from debris and shall be wiped clean if debris exists.
 - b. The working area shall be clean, dry, and the airside of ductwork and air distribution components protected from dust and moisture.
 - c. Protective coverings shall only be removed immediately before installation and inspected to determine if additional wipe down is necessary.
 - d. Open ends on completed ductwork shall be sealed immediately if left for an extended period of time (work breaks, overnight, etc.).
4. Clean new duct system(s) before testing, adjusting, and balancing.
5. For cleaning of existing ductwork, see Section 230130.52 "Existing HVAC Air Distribution System Cleaning."
6. Use service openings for entry and inspection.
 - a. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
 - b. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - c. Remove and reinstall ceiling to gain access during the cleaning process.
7. Particulate Collection and Odor Control:
 - a. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - b. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
8. Clean the following components by removing surface contaminants and deposits:
 - a. Air outlets and inlets (registers, grilles, and diffusers).
 - b. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - c. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - d. Coils and related components.
 - e. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 - f. Supply-air ducts, dampers, actuators, and turning vanes.

- g. Dedicated exhaust and ventilation components and makeup air systems.
- 9. Mechanical Cleaning Methodology:
 - a. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 - b. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 - c. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 - d. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
 - e. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 - f. Provide drainage and cleanup for wash-down procedures.
 - g. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.11 DUCT SCHEDULE

- A. Fabricate ducts except as otherwise indicated shall be constructed from sheets or rolls of G-90 or better-galvanized steel. Fiberglass ductboard is prohibited.
 - 1. Ducts in interior exposed locations shall be constructed of paint-grip galvanized steel.
- B. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
- C. Supply ducts:
 - 1. Pressure Class: Positive 4 inch wg (Pa).
 - 2. Minimum SMACNA Seal Class: A.
 - 3. SMACNA Leakage Class for Rectangular: 4.
 - 4. SMACNA Leakage Class for Round and Flat Oval: 2.
 - 5. Natatorium supply ducts:
 - a. Aluminum
 - b. Exposed to View: No. 3 finish.
 - c. Concealed: No. 2D finish.
- D. Supply ducts downstream of terminal units:
 - 1. Pressure Class: Positive 3 inch wg.
 - 2. Minimum SMACNA Seal Class: B.
 - 3. SMACNA Leakage Class for Rectangular: 8.
 - 4. SMACNA Leakage Class for Round and Flat Oval: 4.
- E. Return ducts:
 - 1. Pressure Class: Negative 3 inch wg.
 - 2. Minimum SMACNA Seal Class: B.
 - 3. SMACNA Leakage Class for Rectangular: 8.

4. SMACNA Leakage Class for Round and Flat Oval: 4.
 5. Natatorium return ducts:
 - a. Aluminum
 - b. Exposed to View: No. 3 finish.
 - c. Concealed: No. 2D finish.
- F. Exhaust ducts
1. Pressure Class: Negative 3 inch wg.
 2. Minimum SMACNA Seal Class: B.
 3. SMACNA Leakage Class for Rectangular: 8.
 4. SMACNA Leakage Class for Round and Flat Oval: 4.
 5. Ducts from showers or other high humidity locations: Shower exhaust where tied to general exhaust shall be aluminum from the air device [to the point indicated on the drawings.]
 - a. Aluminum
 - b. Exposed to View: No. 3 finish.
 - c. Concealed: No. 2D finish.
 6. Exterior ducts:
 - a. Aluminum
 - b. No. 2D finish.
 7. Hazardous exhaust from fume hoods
 - a. 316 stainless steel OR
 - b. PVC coated galvanized steel.
 - c. Minimum SMACNA Seal Class A **OR** Welded seams and joints
 8. Welding fume exhaust
 - a. Pressure Class: Negative 6" w.g.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round and Flat Oval: 2.
 - e. Provide cleanouts at each vertical drop.
 - f. Provide wye-converging flow fittings with the wye-pointed down towards the floor (i.e. the airflow up towards the collector).
 - g. Provide hinged industrial grade cleanout at bottom of equipment riser below wye for clean-out. Caps at bottom of drops are not acceptable.
 - h. Provide "Nordfab" long radius elbows fabricated from 22 gage galvanized steel. Long radius bolted replaceable elbows fabricated from 22 gage stainless steel are also acceptable.
 - i. Blast gates shall be located above each equipment or hood connection in branch ductwork only.
 9. Dust collection ductwork:
 - a. Pressure Class: Negative 6" w.g.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round and Flat Oval: 2.
 - e. All outdoor dust collection ductwork shall be 304SS: Finish meets ASTM A240. Temp rating is 1100°F.
- G. Double wall round ductwork (where scheduled, or indicated on the plans) shall be K-27 double wall internally insulated for sound control and/or thermal performance.

1. All diameters and dimensions shown on the plans are the outside (pressure shell) dimension of the duct.
2. Pressure shell: Spiral lockseam, [Paintable Galvanized Steel], [Galvanized Steel], [Aluminum], [304 Stainless Steel], [316 Stainless Steel]
3. Insulation: 1" thick, 1 pound per cubic foot density, duct liner. (Interior)
4. Insulation: 3" thick, 1 pound per cubic foot density, duct liner. (Exterior supply)
5. Insulation: 2" thick, 1 pound per cubic foot density, duct liner. (Exterior return or exhaust)
6. Inner Liner: Spiral lockseam, [Perforated], [Solid], [Galvanized Steel], [Aluminum], [304 Stainless Steel], [316 Stainless Steel]

END OF SECTION 24 31 00

SECTION 24 30 00 – DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Air Thermometers
 - 2. Dampers and Louvers
 - 3. Flexible Connectors
 - 4. Access Doors and Panels
 - 5. Flexible Ductwork
 - 6. Louvered Penthouses and Intake/Exhaust Hoods
 - 7. Duct Silencers
 - 8. Dryer Outlet Box

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Dampers and Louvers: Air Balance, Arrow United, Greenheck, Nailor, NCA, Pottorff, or Ruskin.
- B. Flexible connectors: Duro Dyne Corporation, Elgen, or Vent-Fabrics.
- C. Access Doors and Panels: Ductmate, Greenheck, Nailor, Ruskin, or approved equivalent.
- D. Flexible Ductwork: Flexmaster, Thermaflex, or approved equivalent.
- E. Louvered penthouses and intake/exhaust hoods: Greenheck, Penn-Barry, Ruskin, United Enertech or approved equivalent.
- F. Duct silencers: Kinetics Noise Control, Nailor, Price, Ruskin, Vibro-acoustics, or approved equivalent.
- G. Duct security bars: Anemostat, Greenheck, Kees, Krueger, Lloyd Industries, Ruskin, United Enertech, or approved equivalent.

2.3 AIR THERMOMETERS

- A. Air thermometers shall be provided and in the supply air, coil discharge of all air handling unit coils, return air, mixed air, and outside air of the air handling units.
- B. Airstream thermometers shall be bimetal type, with an accuracy of 1°F throughout the range with 5" dial size, 12" stem length, ½" N.P.T. back side connector with plain slip ring case of 304 stainless steel, and recalibrator. Thermometer shall be Trerice Model No. B85212 or approved equal as manufactured by Weksler, Marsh, or Marshalltown Instruments. Thermometers for use in the mixed air shall have flexible averaging elements strung with the mixed air temperature sensor and freezestat sensor elements. Mixed air thermometers shall be Trerice No. V80445 with bulb number 4-3-1.
- C. Range shall be as follows:

Outdoor air	-40-160°F
Mixed air	0-100°F
Supply air	25-125°F
Return air	25-125°F
Preheat coil discharge	25-125°F
Reheat coil discharge	25-125°F
Chilled water coil discharge	25-125°F

2.4 BALANCING DAMPER

- A. All dampers, except those located downstream from terminal units used to adjust individual grilles, shall have frames and bearings and shall have quadrant lock regulators with thread screw to allow damper to be securely locked into place.

- B. Balancing dampers downstream from terminal units that are contractor fabricated or apart of manufactured branch fitting shall be a minimum of 18-ga. plate, 3/8" continuous square shaft with locking quadrant handle equal to Duro Dyne model Quadline. Duro Dyne model Duro-Twist, Rossi model Twistlock, or approved equivalent. Duro Dyne model Dyna-Click, Rossi model Everlock, or approved equivalent.
- C. Rectangular dampers up to size 24" x 12" shall be Ruskin MD25, Nailor 1870, Arrow, Air Balance, NCA, or shop fabricated equal, approved by the Engineer.
- D. Round dampers up to size 20" diameter shall be Ruskin MDRS25, Nailor 1890, Arrow, Air Balance, NCA or shop fabricated equal, approved by the Engineer.
- E. Rectangular dampers larger than 24" x 12" shall be Ruskin MD35, Nailor 1820 or equivalent manufactured damper by NCA.
- F. Where volume dampers are to be adjusted through walls or ceilings, such dampers shall be operated by regulators designed for recessed installation and provided with a cover plate which shall be flush to the surface of the wall or ceiling. Concealed regulators, as manufactured by Duro Dyne Corporation or Elgen shall be of the indicator type. The regulator shall be provided with a spring washer for non-binding adjustment and hex lock nut in addition to wedge pin which shall be installed to prevent damper rattle. Cast alloy regulator housing, with "open to shut" range positioning markers, shall be secured with removable cover to expose the regulator for adjustments.

2.5 CONTROL DAMPERS

- A. All automatic dampers and control dampers shall be as specified in Division 25, "Temperature Control". Dampers shall be furnished under Division 25 for installation under Division 23 30 00.

2.6 FIRE DAMPERS

- A. Fire dampers shall be provided as indicated on the plans. Dampers shall be U.L. 555 listed under N.F.P.A. Pamphlet #90-A.
 - 1. Dampers for rectangular ductwork shall be Style B
 - 2. Dampers for round or oval ductwork shall be Style C.
 - 3. In both cases the curtain shall be located outside of the airstream.
 - 4. Factory wall sleeves are not permitted.
 - 5. Closure springs shall be furnished for both horizontal and vertical installations.
- B. Dampers rated for installation in up to 2-hour fire resistive construction shall be Ruskin Type IBD2, Nailor model 0120/0130, Air Balance model 119, Greenheck model FD-150, or approved equivalent.
- C. Fire dampers rated for installation in greater than 2-hour fire resistant construction shall be Ruskin Type IBD23, Nailor model 520/530, Air Balance model 319, Greenheck model FD-350, or approved equivalent.
 - 1. Dampers up to 324 square inches shall be Greenheck Ruskin type CFD-2, Nailor 0716, NCA CD-S/R

2. Dampers for areas between 324 square inch minimum and 576 square inch maximum shall be Ruskin CFD-4.
3. Frame: 2" x ½" x 16 gauge galvanized steel frame.
4. Damper shall be classified and approved under UL 555C.
5. Where volume dampers are indicated on the air device schedule along with ceiling radiation dampers, provide a fusible volume adjustment on the radiation damper blades equal to Ruskin CFD-2A or CFD-4A, Nailor 0716A, or NCA CD-S/R A.

2.7 FIRE-SMOKE DAMPERS

- A. Combination fire-smoke dampers with steel airfoil blades meeting requirements of the latest edition of UL Standard 555 and UL Standard 555S.
 1. Each combination fire-smoke damper shall be equipped with a factory installed electrically-resettable heat responsive device rated to close the damper when the temperature at the damper reaches 165°F.
 2. Dampers shall have a UL555S leakage rating of Leakage Class I for airflow in either direction and shall have a minimum UL 555S differential pressure rating of 4 in. wg.
 3. Dampers shall have a minimum UL 555S velocity rating of 2000 fpm.
- B. Damper frame shall be 16 ga. galvanized steel formed into a 5" structural hat channel.
 1. Top and bottom frame members on dampers less than 17" high shall be low profile design to maximize the free area of these smaller dampers.
 2. Frame shall be 4-piece construction with 1 ½" (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking.
- C. Damper blades shall be 16 ga. galvanized steel with full length structural reinforcement and a double skin true airfoil shape.
 1. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper.
 2. Blade seals shall be extruded silicone rubber permanently bonded to the appropriate blade edges.
 3. Jamb seals shall be flexible stainless steel compression type.
 4. Linkage shall be concealed in the jamb.
 5. Axle bearings shall be permanently lubricated stainless steel or sintered bronze sleeve type rotating in polished extruded holes in the damper frame.
- D. Actuators shall be listed with the damper assembly and be electrically operated, [120 VAC, 24 VAC] power supply. Actuators shall be 2-position and shall fail in [a closed] direction.
- E. Damper options
 1. Damper assembly shall come with a factory-mounted permanent momentary test switch to operate the damper for inspection.
- F. Dampers shall have a UL 555 fire resistance rating of 1½ hours shall be Greenheck FSD-311, Nailor 1220, NCA FSD-AF, Ruskin FSD60, or approved equivalent.

2.8 SMOKE DAMPERS

- A. Smoke dampers with steel airfoil blades meeting requirements of UL Standard 555S, latest edition.
 - 1. Dampers shall have a UL555S leakage rating of Leakage Class I for airflow in either direction and shall have a minimum UL 555S differential pressure rating of 4 in. wg.
 - 2. Dampers shall have a minimum UL 555S velocity rating of 2000 fpm.
- B. Damper frame shall be 16 ga. galvanized steel formed into a 5" structural hat channel.
 - 1. Top and bottom frame members on dampers less than 17" high shall be low profile design to maximize the free area of these smaller dampers.
 - 2. Frame shall be 4-piece construction with 1 ½" (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking.
- C. Damper blades shall be 16 ga. galvanized steel with full length structural reinforcement and a double skin airfoil shape.
 - 1. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper.
 - 2. Blade seals shall be extruded silicone rubber permanently bonded to the appropriate blade edges.
 - 3. Jamb seals shall be flexible stainless steel compression type.
 - 4. Linkage shall be concealed in the jamb.
 - 5. Axle bearings shall be permanently lubricated stainless steel or sintered bronze sleeve type rotating in polished extruded holes in the damper frame.
- D. Actuators shall be listed with the damper assembly and be electrically operated, [120 VAC, 24 VAC] power supply. Actuators shall be 2-position and shall fail in [a closed] direction.
- E. Damper options
 - 1. Damper assembly shall come with a factory-mounted momentary permanent test switch to operate the damper for inspection.
- F. Dampers shall be Ruskin SD60, Greenheck SMD-301, or approved equivalent.

2.9 AIR TURNING VANES

- A. Furnish and install directional air turning vanes in ductwork at all 90 degree mitered elbows and 90 degree radiused elbows.
- B. Mitered 90 degree elbows vanes shall be:
 - 1. Single rolled type with a radius of 2" with 1.5" spacing.
 - 2. Single rolled type with a radius of 4-1/2" with 3.25" spacing.
 - 3. Double thickness type with a radius of 4-1/2" with 3.25" spacing. Double thickness 2" radius is not allowed.
 - 4. Tie rods shall be used to limit the maximum unsupported width per the type of vane used per SMACNA.
 - 5. Vanes shall be solidly installed and rattle-free locked into each slot of preformed vane guide rails as manufactured by Duro Dyne Corporation or Elgen. Rails shall be

constructed of 24 gauge galvanized steel, specially embossed for extra strength and sturdiness.

- C. Radiused 90 degree elbows shall have 2 vanes. Vanes shall be single thickness, Splitter Vanes for radius elbows shall be fabricated based on the "SMACNA HVAC Systems Duct Design Manual" using the appropriate curve ratio.

2.10 FLEXIBLE CONNECTORS

- A. Flexible connections shall be U.L. listed fabric that meets NFPA 90A. It shall weigh not less than 24 oz per sq. yd and have a tensile strength of not less than 500 psi. Flexible connections shall be preassembled "Super Metal-Fab" with 6" fabric attached to 3" metal on either side by means of "Grip-Loc" seam. At least one inch of slack shall be allowed when making connection to insure that no vibration is transmitted from fan to ductwork.
 - 1. Flexible connectors shall be No. MF6N as manufactured by Duro Dyne Corporation, or equivalent by Vent-Fabrics or Elgen.
 - 2. Flexible connectors for exposed interior ductwork shall be DuroDyne Insulflex or approved equivalent.
 - 3. Flexible connections on **exterior** ductwork shall be manufactured with DuroDyne Excelon fabric, Vent Fabrics Ventlon, or approved equivalent.

2.11 ACCESS DOORS and PANELS

- A. 2" Pressure Class: Door shall be SMACNA Standard, 12" x 12", double skin, 1" fiberglass insulation, with underside duct to frame gasket for reduced leakage.

<Solid without window Ruskin ADH22, Nailor 08SH, Greenheck HAD-10, Ductmate FDH, or equivalent.>

<With window Ruskin ADHW22, or equivalent.>
- B. 4" and Higher Pressure Class: Oval shape, ultra low leakage at 8" w.c.

<Solid without window Nailor 0800, Greenheck RAD, Ductmate Sandwich, or equivalent.>

<With window Ductmate Observation Access Door.>
- C. Access doors in casings and housings shall be fabricated double skin doors with 1" thick insulation between inner and outer surface as detailed in the SMACNA Duct Manual. Provide two compression latches equal to Ventlok #260 on each door. Where access doors provide for personnel entry into the system, they must be provided with inside/outside latch hardware. Provide access doors at all locations indicated on the drawings and into the mixing chamber of all air handling units. Size shall be 18 x 36, unless indicated otherwise on the drawings. Ruskin GPAD or equivalent.
- D. For access panels required in ceiling, walls, etc. of the building construction, see Section 20 10 10.

2.12 FLEXIBLE DUCTWORK

A. Performance Requirements:

1. Comply with NFPA 90A and NFPA 90B.
2. Comply with U.L. 181
3. Comply with ASTM E96/E96M.
4. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials must be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
5. Comply with the Air Duct Council's (formerly, Air Diffusion Council) "ADC Flexible Air Duct Test Code - FD 72-R1" and "Flexible Duct Performance & Installation Standards."
6. Comply with ASTM E96/E96M.

B. Construction:

1. Duct Fabric: A double lamination of tough polyester, which encapsulates a steel wire helix
2. Duct Helix: Spring steel galvanized helix.
3. Pressure rating: minimum of 6" w.g. positive and 0.5" w.g. negative.
4. Vapor barrier: Metallic
5. Insulation: Glass fiber, R-4.2 in Return Air Plenum, otherwise R-6
6. WARRANTY: minimum 5-year product warranty

C. Flexible duct shall be Flexmaster Type 9M, Thermaflex M-KE, or equivalent.

D. Construction:

1. Duct Fabric: A Polyethylene fabric, mechanically locked to the duct helix without the use of adhesives.
2. Duct Helix: Made from corrosive resistant galvanized steel, the duct helix is mechanically formed to attach the duct fabric without the use of adhesives.
3. Pressure rating: minimum of 10" w.g. positive and 5" w.g. negative thru 16".
4. Vapor barrier: Metallic
5. Insulation: Glass fiber, R-4.2 in Return Air Plenum, otherwise R-6
6. WARRANTY: minimum 20-year product warranty

E. Flexible duct shall be Flexmaster Type 1M, no substitutions allowed.

F. Construction:

1. Duct Fabric:
2. Duct Helix:
3. Pressure rating: minimum of _____" w.g. positive and _____" w.g. negative thru _____" size.
4. Metallic vapor barrier
5. R-____ insulation

G. Manufactures:

2.13 INTAKE / EXHAUST HOOD

- A. Intake/Exhaust hoods shall be heavy gauge aluminum construction with hinged hoods designed for intake or exhaust. All seams shall be continuously welded with lock formed seams. Hoods shall be stressed and sloped for drainage. Provide expanded aluminum birdscreen and roof curb to provide a height of 12" above the finished roof. Hood performance shall be based upon maximum inlet velocity of 600 fpm and a maximum pressure drop of .10" w.c., exhaust hoods shall have a maximum pressure drop of .15" w.c. The Contractors shall coordinate the curbs with the roof insulation thickness.
- B. Hoods shall be Cook VI/VR, Penn-Barry Airette, Greenheck, United Enertech or equivalent.
- C. Field fabricated exhaust goosenecks shall be aluminum construction with all joints sealed with an exterior sealant. The termination shall be a minimum of 18" above the roof. Provide expanded aluminum birdscreen.

2.14 STATIONARY DRAINABLE LOUVER

- A. Louvers shall be high performance low pressure drop, low water penetration and drainable.
- B. Louvers performance shall be AMCA Certified and shall meet or exceed the following specifications:
 - 1. Static pressure drop: 0.15" or less at 1000 FPM through free area.
 - 2. Water penetration: Beginning point at .01 oz/ft² - 1000 FPM minimum
 - 3. Free Area: 50% minimum
- C. Louver frame and blades shall be fabricated from 0.80" thick extruded aluminum alloy 6063-T5. Blades and jambs shall have integral gutters for drainage of water. Blades shall be at a 37.5° angle on centers not exceeding 6". Each louver shall be designed to withstand a wind load or other load of 20 pounds per square foot. Birdscreen shall be framed, rear mounted, and removable of 3/4" x 0.051" expanded flattened aluminum.
- D. Where louvers must be made up by multiple sections, the manufacturer shall submit with the shop drawings, all joint locations, methods of bracing/assembly. When the louvers are assembled per the shop drawings they shall meet the above specified structural loading.
- E. Louvers shall have a Kynar 500 finish with a dry film thickness of 1.2 mils. Color to be chosen by the Architect/Engineer from the manufacturer's standard colors, or custom color where scheduled or indicated, at time of shop drawing submittals.
 - 1. Kynar finish shall have 20 year warranty. Finish coating shall not peel, blister, chip, crack or check. Chalking, fading or erosion of finish when measured by the following tests:
 - a. Finish coating shall not chalk in excess of 8 numerical ratings when measured in accordance with ASTM D4214.
 - b. Finish coating shall not change color or fade in excess of 5 NBS units as determined by ASTM D2244 and ASTM D822.
 - c. Finish coating shall not erode at a rate in excess of 10%/ 5 year as determined by Florida test sample.
- F. Louvers shall be Ruskin Model ELF6375DX, Greenheck Model EDK-602, or approved equivalent by Arrow Model 265, NCA Model XAD-6.

2.15 WIND DRIVEN RAIN LOUVER

- A. Louvers shall be high performance low pressure drop, low water penetration and drainable.
- B. Louvers performance shall be AMCA Certified and shall meet or exceed the following specifications:
 - 1. Based on testing 48 inches x 48 inches size unit in accordance with AMCA 500-L.
 - 2. Free Area: 44 percent, nominal.
 - 3. Free Area Size: 6.99 square feet.
 - 4. Maximum Recommended Air Flow through Free Area: 1,361 fpm.
 - 5. Air Flow: 9514 cfm.
 - 6. Maximum Pressure Drop (at 1361 feet per minute): 0.20 inches w.g. (0.05 kPa).
- C. Wind Driven Water Penetration Performance:
 - 1. Based on testing 39 inches x 39 inches (1 m x 1 m) core area, 41 inches x 44 inches (1.04 m x 1.12 m) nominal size unit in accordance with AMCA 500-L.
 - 2. Wind Velocity: 29 mph (47 kph).
 - a. Rainfall Rate: 3 inches/hour (76 mm/hour).
 - b. Free Area Velocity: 1361 feet per minute (6.9 m/s).
 - c. Water Resistance Effectiveness: 99.7% (AMCA Class A).
 - 3. Wind Velocity: 50 mph (80 kph).
 - a. Rainfall Rate: 8 inches/hour (203 mm/hour).
 - b. Free Area Velocity: 778 feet per minute (4.0 m/s).
 - c. Water Resistance Effectiveness: 99.0% (AMCA Class A).
- D. Design Windload: Incorporate structural supports required to withstand wind load of 20 pounds per square foot.
- E. Louver frame shall be fabricated from 0.081" thick extruded aluminum alloy 6063-T6.
- F. Louver blades shall be sightproof, double drainable, fabricated from 0.063" thick extruded aluminum alloy 6063-T6, on centers not exceeding 2".
- G. Birdscreen shall be framed, rear mounted, and removable of 3/4" x 0.051" expanded flattened aluminum.
- H. Where louvers must be made up by multiple sections, the manufacturer shall submit with the shop drawings, all joint locations, methods of bracing/assembly. When the louvers are assembled per the shop drawings they shall meet the above specified structural loading.
- I. Louvers shall have a Kynar 500 finish with a dry film thickness of 1.2 mils. Color to be chosen by the Architect/Engineer from the manufacturer's standard colors, or custom color where scheduled or indicated, at time of shop drawing submittals.
 - 1. Louver shall have a 5year warranty.
 - 2. Kynar finish shall have 20 year warranty. Finish coating shall not peel, blister, chip, crack or check. Chalking, fading or erosion of finish when measured by the following tests:
 - a. Finish coating shall not chalk in excess of 8 numerical ratings when measured in accordance with ASTM D4214.
 - b. Finish coating shall not change color or fade in excess of 5 NBS units as determined by ASTM D2244 and ASTM D822.

- c. Finish coating shall not erode at a rate in excess of 10%/ 5 year as determined by Florida test sample.
- J. Louvers shall be Ruskin Model EME520DD, Greenheck Model EHH-501, or approved equivalent by Air Balance Inc., Arrow, or NCA.

2.16 DUCT SILENCERS

- A. Furnish and install factory-fabricated and field-installed duct silencers as indicated on the drawings.
- B. General Requirements:
 - 1. Factory fabricated.
 - 2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
 - 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 - 4. Bearing AMCA's Certified Ratings Seal for prefabricated silencer sound and air performance.
- C. Shape:
 - 1. Rectangular straight with splitters or baffles.
 - 2. Round straight with center bodies or pods.
 - 3. Rectangular elbow with splitters or baffles.
 - 4. Round elbow with center bodies or pods.
 - 5. Rectangular transitional with splitters or baffles.
- D. Rectangular Silencer Outer Casing: ASTM A653/A653M, G90, galvanized sheet steel, 22 gauge thick.
- E. Round Silencer Outer Casing: ASTM A653/A653M, G90 galvanized sheet steel.
 - 1. Sheet Metal Thickness for Units up to 24 inches in Diameter: 22 gauge thick.
 - 2. Sheet Metal Thickness for Units 26 through 40 inches in Diameter: 20 gauge thick.
 - 3. Sheet Metal Thickness for Units 42 through 52 inches in Diameter: 18 gauge thick.
 - 4. Sheet Metal Thickness for Units 54 through 60 inches in Diameter: 16 gauge thick.
- F. Inner Casing and Baffles: ASTM A653/A653M, G90 galvanized sheet metal, 22 gauge thick, and with 1/8-inch diameter perforations.
- G. Special Construction:
 - 1. Suitable for outdoor use.
 - 2. High transmission loss casing to achieve STC 45 <Insert value>.
- H. Connection Sizes: Match connecting ductwork unless otherwise indicated.
- I. Principal Sound-Absorbing Mechanism:
 - 1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
 - 2. Dissipative, [film-lined] type with fill material.

- a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 10 percent compression.
 - b. Erosion Barrier: Polymer bag enclosing fill, heat-sealed before assembly.
3. Lining: Tedlar [None].
- J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
 1. Joints: Lock formed and sealed, flanged connections.
 2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
 3. Reinforcement: Cross or trapeze angles for rigid suspension.
- K. Accessories:
 1. Integral [1-1/2] [3]-hour fire damper with access door. [Access door to be high transmission loss to match silencer.]
 2. Factory-installed end caps to prevent contamination during shipping.
 3. Removable splitters.
 4. Airflow-measuring devices.
- L. Source Quality Control:
 1. Test in accordance with ASTM E477.
 2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000 fpm face velocity.
 3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

2.17 DRYER OUTLET BOX

- A. Furnish and install factory-fabricated and field-installed metal dryer outlet box as indicated on the drawings, coordinate framing with other trades as required for proper opening size and installation.
- B. Construction:
 1. Powder-coated 22 gauge steel, white, or aluminized steel.
 2. Snap-on trim ring.
 3. Size: 19-1/2" tall x 12-1/2" wide x 5-1/2" deep.
- C. Dryer Outlet Box shall be Construction Solutions DBX1000M-6, IPS DB425 or approved equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories in conformance with applicable SMACNA standards.

- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.
- C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
- D. Volume Damper Installation
 - 1. Furnish and install volume dampers at each main branch take-off and in such other locations where required to properly balance the air distribution systems.
- E. Control Damper Installation
 - 1. Dampers installed in walls shall be installed with wall sleeves to allow direct coupled actuator installation.
 - 2. Large damper installations with multiple actuators shall be installed with 8" sheetmetal blank-off/spacers between them to allow direct coupled actuator installation. Provide structural supports as required for a straight, true, level and square installation.
 - 3. Dampers shall be attached with fasteners on 6" centers with a minimum of 2 per side.
 - 4. Access panels [with window] [without window] shall be provided at all duct mounted automatic control dampers.
- F. Life Safety Damper Installation
 - 1. Fire, smoke and fire-smoke dampers shall be provided as indicated on the plans and/or schedules. If not scheduled, dampers shall be the full size of the duct they are associated with unless noted otherwise.
 - 2. Access panels [with window] [without window] shall be provided at all fire, smoke and fire-smoke damper installations to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 3. Install fire, smoke and fire-smoke dampers in accordance with UL listing.
 - 4. Diffusers and returns in two (2) hour rated floor/ceiling assemblies shall be equipped with ceiling fire/radiation dampers suitable for this application. Where volume dampers are indicated on the air device schedule along with ceiling radiation dampers, provide a fusible volume adjustment on the radiation damper.
- G. Flexible Connector Installation
 - 1. Furnish and install flexible connections at the connections to air handling equipment as indicated on the plans. The flexible connectors shall be fastened to ductwork and equipment by screws, rivets or spot welding.
 - 2. For fans developing static pressures of 5 inches wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
 - 3. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.
- H. Access Door and Panel Installation
 - 1. Access doors and panels shall be provided as noted herein, upstream of duct mounted reheat coils, multi-zone dampers and as shown on drawings.

2. Access door and panels shall be installed to swing against the duct static pressure.
- I. Intake / Exhaust Louvers, Hoods, Penthouse, Etc.
 1. Furnish and install building air inlets / outlets as sized on the drawings, coordinate opening framing with other trades as required for proper opening size and installation.
 2. Install FEMA rated louvers per manufacturer's instructions to maintain FEMA rating.
- J. Duct security bars:
 1. Connect duct security bars to ducts with flexible connections. Provide 12-by-12-inch hinged access panel with cam lock in duct in each side of sleeve.
 2. Secure duct security bar assembly to building structure as indicated in manufacturer's installation instructions.
- K. Dryer outlet box:
 1. Install dryer outlet box recessed into wall construction.
 2. Install box level and plumb.
 3. Extend dryer vent piping into box a minimum of 6" or length necessary to attach flex vent.

3.2 FIELD QUALITY CONTROL

- A. Life Safety Damper Testing
 1. Fire and fire/smoke dampers are to be witness tested by the Owner. The Contractor shall remove the fusible link and demonstrate that the damper closes freely. After acceptance by the Owner, the Contractor shall reset the damper and replace the fusible link.
 2. Inspect life safety damper access to verify the size is adequate to perform the required operation.
 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
- B. Air Duct Accessory Tests and Inspections
 1. Operate dampers to verify full range of movement.
 2. Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
 3. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
 4. Operate remote damper operators to verify full range of movement of operator and damper.
 - 5.
- C. Flexible Ductwork
 1. Flexible duct length shall not exceed 8' for diffusers and 3' at VAV box inlets.
 2. Support flexible duct on 4' centers maximum.
 3. Flexible duct shall be attached with zinc plated or stainless steel worm drive duct hose clamps.
 4. Install ducts fully extended.
 5. Do not bend ducts across sharp corners.
 6. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
 7. Avoid contact with metal fixtures, water lines, pipes, or conduits.

8. Install flexible ducts in a direct line, without sags, twists, or turns.

3.3 CLEANING AND PROTECTION

- A. Clean and protect duct accessories to the same requirements for ductwork.

END OF SECTION 24 30 00

SECTION 24 33 50 – INTERNAL ACOUSTICAL DUCT LINING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Duct lining.
- B. Furnish and install duct lining as indicated on drawings and scheduled below.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Duct liner shall be tested in accordance with test method ASTM C423, Type ‘A’ mounting and have absorption coefficient performance equal to or greater than the table below:

Thickness	Frequency					
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
1/2"	0.03	0.10	0.25	0.40	0.53	0.69
1"	0.07	0.25	0.54	0.73	0.83	0.95
1-1/2"	0.17	0.39	0.72	0.88	0.95	0.95
2"	0.24	0.53	0.83	0.95	0.95	0.95

2.2 MANUFACTURERS

- A. Fibrous glass, Type I:
 - 1. Johns Manville Linacoustic RC
 - 2. Johns Manville Spiracoustic Plus (round ductwork).
 - 3. Knauf Liner M
 - 4. Owens Corning Aeroflex Plus Type 200
 - 5. Schuller Permacote Linacoustic Standard
- B. Fibrous-glass-free, natural fiber:
 - 1. Acoustical Surfaces, Inc. - Quietliner™
 - 2. Bonded Logic
 - 3. Ductmate PolyArmor
- C. Flexible Elastomeric:
 - 1. Armacell, ArmaFlex, ArmaFlex FS
 - 2. K-Flex
- D. Polyolefin:
 - 1. Aerofoam AeroSound
 - 2. Sekisui Thermobreak™ AcoustiPlus

2.3 DUCT LINER

- A. Acoustical lining shall be a single layer of the thickness scheduled with 90% adhesive coverage applied to the ductwork and the liner applied mat face up.
- B. Mechanically welded pins with push on metal heads shall be used on ducts larger than 12" x 12". Pins shall be copper or shall be as corrosion resistant as the G-90 coated galvanized steel. Spacing around the perimeter shall be 4" from longitudinal liner edges and at intervals not exceeding 12". Transversely the spacing shall be 3" from transverse joints and at intervals not exceeding 18".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing conditions....

3.2 INSTALLATION

- A. Internal duct areas shall be completely covered with duct liner. Each ductwork section shall be covered with a single sheet per side of ductwork, scraps or pieces shall not be used. Longitudinal joints in corners shall be overlapping butt joints. Transverse joints shall be coated with adhesive at the shop prior to shipping the ductwork to the job site and at the time of installation the joints

shall be recoated to adhere to one another. Metal nosing and longitudinal joint sealant shall be applied to the first four (4) sections of ductwork at the fan discharge.

- B. At all locations of branch fittings, the edges of the main duct liner and the start of branch duct liner shall be sealed with duct liner adhesive.
- C. All rips, tears, or other damaged liners shall be repaired by coating the damaged area with liner adhesive. Sections that are not repairable shall be scraped and refabricated.
- D. Ductwork with internal lining shall be protected during shipping and at the job site to prevent the liner from getting wet. Ductwork shall not be stood on end or lay directly on the floor of buildings which are not weathertight. In the event that the liner becomes wet it shall be dried in accordance with the manufacturer's instructions.

3.3 CLEANING AND PROTECTION

- A. Clean duct lining per the requirements for duct cleaning.

3.4 DUCT LINER SCHEDULE

- A. Schedule [define area this applies]
 - 1. Supply-Air Ducts:
 - a. Type: [Fibrous glass, Type I] [Flexible elastomeric] [Fibrous-glass-free, natural fiber] [Polyolefin],
 - b. Thickness: [1/2] [1] [1-1/2] [2] <Insert dimension> inch thick.
 - 2. Return-Air Ducts:
 - a. Type: [Fibrous glass, Type I] [Flexible elastomeric] [Fibrous-glass-free, natural fiber] [Polyolefin],
 - b. Thickness: [1/2] [1] [1-1/2] [2] <Insert dimension> inch thick.
 - 3. Exhaust-Air Ducts:
 - a. Type: [Fibrous glass, Type I] [Flexible elastomeric] [Fibrous-glass-free, natural fiber] [Polyolefin],
 - b. Thickness: [1/2] [1] <Insert dimension> inch thick.
 - 4. Supply Fan Plenums:
 - a. Type: [Fibrous glass, Type II] [Flexible elastomeric] [Fibrous-glass-free, natural fiber] [Polyolefin],
 - b. Thickness: [1/2] [1] [1-1/2] [2] <Insert dimension> inch thick.
 - 5. Return- and Exhaust-Fan Plenums:
 - a. Type: [Fibrous glass, Type II] [Flexible elastomeric] [Fiberglass-free, natural fiber] [Polyolefin],
 - b. Thickness: [1/2] [1] [1-1/2] [2] <Insert dimension> inches thick.
 - 6. Transfer Ducts:
 - a. Type: [Fibrous glass, Type I] [Flexible elastomeric] [Fibrous-glass-free, natural fiber] [Polyolefin],
 - b. Thickness: [1/2] [1] [1-1/2] [2] <Insert dimension> inch thick.
 - 7. Architectural Return Chases:

- a. Type: [Fibrous glass, Type I] [Flexible elastomeric] [Fibrous-glass-free, natural fiber] [Polyolefin],
- b. Thickness: [1/2] [1] [1-1/2] [2] <Insert dimension> inch thick.

B. Schedule (Area XX).

END OF SECTION 24 33 50

SECTION 24 34 00 – FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backward-inclined centrifugal fans, including airfoil and curved blade fans.
2. Centrifugal ventilators - roof downblast.
3. Square in-line centrifugal fans.
4. Utility set fans.
5. Upblast propeller roof exhaust fans.
6. Mixed-flow fans.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

1. Provide fans as scheduled on the drawings.
2. Provide accessories as scheduled on the drawings.
3. Provide hangers, supports, isolators, curbs, etc. as necessary for the installation of the fans.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.3 CENTRIFUGAL FANS

- A. Centrifugal fans shall have capacities and minimum wheel diameters, wheel type, and class as indicated on the schedule. Each fan shall be of the non-overloading centrifugal type with deep drawn inlet rings, streamlined housing continuously welded and scroll, blades continuously welded to the flange, solid backplate, full curved shroud, and flanged discharge collar. Where Class II construction is required, wheels shall be reinforced with a welded intermediate ring. Fans shall be statically and dynamically balanced. Provide drain openings at the bottom of fan scroll. Fans shall be spark resistance Type C, Fans and motors shall be Arrangement 10, mounted on structural steel bases of continuously welded sections to form a rigid chassis.
- B. Air Foil fans shall be Cook CA, Greenheck AF Series 41, ACME 8100, or approved equal.
- C. Back Incline fans shall be Cook CPS, Greenheck BI Series 41, ACME 3000, or approved equal.

2.4 ROOF EXHAUSTERS

- A. Furnish and install where indicated on the drawings centrifugal roof exhaust fans of the sizes and capacities as scheduled. Centrifugal impeller is to be of heavy aluminum construction with backward inclined or curved hollow airfoil blades. Hoods shall be constructed of aluminum with rolled bead for additional strength and shall be easily removable for servicing. Overall height from the curb shall not exceed that of the models scheduled. Motor and drive assembly shall be vibration isolated from the base and housing. All units shall have U.L. wired safety disconnect switch, sound attenuating roof curb and backdraft damper, in addition to any other accessories listed in the schedule.
- B. Fans shall be Cook ACE-B, Greenheck GB, Penn-Barry, Domex, ACME PNN or approved equal.

2.5 IN-LINE CENTRIFUGAL

- A. In-line centrifugal fan wheel shall be statically and dynamically balanced aluminum backward inclined blades with deep drawn inlet. Fan housing shall be steel construction with hinged access door. Fan construction shall allow complete servicing without removing the fan from the ductwork.
- B. Belt driven fans shall have motor out of the air stream. Direct drive fans will have motor in the air stream.
- C. Each fan shall have a wired safety disconnect switch.
- D. Fans shall be Cook SQI/SQN as scheduled, Greenheck BSQ, Penn-Barry, SXBC, ACME XB, or approved equal.

2.6 UTILITY FAN

- A. Utility fans shall be belted vent sets with heavy duty, quiet operating centrifugal fans with backward inclined or forward curved wheels as scheduled, heavy steel scrolls, riveted or welded

blades, polished steel shaft and removable guard assembly over the drive equipment. Fans shall be spark resistance Type C. Fans shall have inlet collars and outlet flanges. Provide drain openings at the bottom of each fan scroll. Each utility set shall be provided with captive spring type isolation mountings equipped with built-in leveling devices and sound attenuating rubber pads. The isolation medium shall be steel springs with 2" deflection and shall be Mason Industries Type "SLR" or equivalent by Korfund, Vibration Eliminator Company, ACME Engineering, or fan manufacturer.

- B. Forward curve fans shall be Cook CPF-B, Greenheck SFB, or approved equal.
- C. Backward inclined fans shall be Cook CPV, Greenheck SWB, Pen-Barry, Model Dynamo, ACME QBR, or approved equal.

2.7 PROPELLER FAN

- A. Propeller panel fans shall be industrial duty belt driven types. Panels shall be heavy steel, square with flanged edges, intermediate stiffeners and deep-throated orifices. Motor and steel supports shall be channel or plate type suitable for motor and wheel specified. Fans shall be equipped with adjustable pitch "V" belts drive selected for 1.5 times the motor horsepower and with belt guard, motor sliderail base and dripproof motor.
- B. Fans shall be Cook, Aerovent, American Coolaire, or Acme Engineering and Manufacturing of the wheel diameters scheduled.

2.8 MIXED FLOW

- A. Tubular mixed-flow inline blowers shall have steel wheel, non-overloading, high efficiency, balanced mixed-flow type. Contoured single thickness blades shall incorporate 3-D curvature for maximum efficiency across the entire surface of the blade. Blades shall be continuously welded to the backplate and inlet shroud. Fans shall be belt driven motor out of the air stream. Each fan shall have a wired safety disconnect switch. Motor should be mounted 90 degrees off from base.
- B. Fans shall be Greenheck QEI, Cook QMX, Penn Barry ESI, Twin City Fans or approved equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Accessories shall be provided as scheduled on the drawings.
- B. Install fans level and plumb.
- C. Lift equipment with manufacturer's designated lifting points.
- D. Equipment Mounting

1. Secure roof mounted fans to roof curbs.
2. Install floor -mounted centrifugal fans on cast-in-place concrete equipment base(s).
3. Ceiling units shall be suspended from structure; use steel wire or metal straps. Suspend equipment from manufacturer's designated supporting points.
4. Maintain manufacturer's recommended service clearance.
5. Equipment shall be labeled in compliance with specifications.

- E. Comply with requirements for vibration isolation.
- F. Comply with requirements for seismic restraint.
- G. Comply with manufacturer's recommended startup requirements.

3.2 DUCTWORK CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

3.3 CENTRIFUGAL FAN INSTALLATION

- A. Support fan bases on isolation mountings equipped with built-in leveling devices and sound attenuating rubber pads. The isolation medium shall be steel springs with 1-1/2" deflection and shall be Korfund Type "L" with seismic restraints or equivalent by Mason Industries, Vibration Eliminator Company, Acme Engineering, or fan manufacturer.

3.4 ROOF EXHAUSTER INSTALLATION

- A. Install a vinyl coated steel cable from the motor cover to the base to allow the motor cover to be removed for service, but will not permit the cover to be blown away. Cable shall have eyelet or swagged ends with aluminum or galvanized fasteners.

3.5 IN-LINE CENTRIFUGAL FAN INSTALLATION

- A. Support fan from spring isolators.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation where applicable.
- B. Adjust belt tension for belt driven fans.
- C. Lubricate bearings.
- D. Comply with requirements for Testing, Adjusting and Balancing.

3.7 FIELD QUALITY CONTROL

- A. Perform fan operational test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- B. Test and adjust controls and safeties.

3.8 CLEANING AND PROTECTION

- A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

END OF SECTION 24 34 00

SECTION 24 35 00 – DUST COLLECTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 2. Dust collector.
 - 3. Dust collection ductwork.
 - 4. Dust collection accessories.
- B. Furnish and install complete dust collection system as shown on the drawings and specified herein, including collector, ductwork, accessories, and extinguishing system.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 DUST COLLECTOR

- A. Dust collector shall be manufactured for indoor installation with sealed hoppers and a single (1) 55-gallon drum. Motor and fan shall be enclosed from elements. Shaker and shaker motor shall be enclosed from elements. Dust collector shall be designed for explosion venting. Explosion

vent from dust collector shall direct an explosion upward. Filter bags shall be provided with unit. Dust collector shall be an UMA 250 or approved equivalent.

- B. Hopper explosion protection: UMA factory-made sealed 55-Gal. drum kit or approved equivalent shall be installed on dust collector hopper according to manufacturer specifications.
- C. Dust collector isolation:
 - 1. Rembe Q-Flap or approved equivalent shall be provided for explosion protection on the inlet side of the dust collector. Inlet flap valve is to be manually armed and held open via magnets.
 - 2. Rembe Q-Rohr or approved equivalent flameless explosion vent shall be provided on the discharge of the collector.
 - 3. A spark detector activated extinguishing system shall be installed on the inlet duct to the dust collector. System shall be Fagus GreCon BS7 or approved equivalent. Coordinate water supply connection requirement to extinguishing system with fire protection contractor.
 - 4. Option – contractor can propose a performance based design in compliance with NFPA 654 and NFPA 664 with substitutions or elimination of various components listed above, contingent on approval by the AHJ.

2.3 DUST COLLECTION DUCTWORK

- A. Dust Collector Ducting shall consist of the following:
 - 1. All indoor dust collection ductwork shall be Galvanized: ASTM A653 with a G90 rating. Recommended max. service temperature is 390°F.
 - 2. All outdoor dust collection ductwork shall be 304SS: Finish meets ASTM A240. Temp rating is 1100°F.
- B. Ducting manufacturing techniques:
 - 1. Diameters 3" - 24" Quick-Fit pipe, adjustable nipples, and collars attached to other components will have one or both ends die formed-rolled to provide a uniform edge around the circumference of the rolled end. The pipe and adjustable nipples shall have the longitudinal seam laser welded to allow for a tighter slip joint and reduce system pressure losses. All laser welded seams will undergo a light test to ensure there are no voids or imperfections in the system. Pipe lengths using laser welded seams will not exceed a nominal 60" length. The rolled edges provide structural support at 5' intervals or less and can be interpreted as a stiffener where SMACNA specifications are required. An adjustable nipple is used for adjustment during the install process. Pipe is cut to appropriate length and the adjustable nipple secures the pipe for install.
 - 2. Quick-Fit pipe and components larger than 24" shall utilize either an angle flange or flat flange attached loosely and retained in place using a 3/8" Vanstone lip. The flanged pipe shall have a solid welded seam and not exceed nominal 60" length. The angle or flat flanges provide structural support at 5' intervals or less and are considered as stiffeners where SMACNA specifications are required.
 - 3. Ducting and its components shall be factory tested to +/- 80" WG on pipe diameters 3" to 20" and will use 22 gage material thickness for 3" to 12" duct and 20 gage for larger duct.
- C. Clamping rolled edged duct:

1. Clamps shall be constructed with an over-center, spring-lever action for quick connecting of two pieces of ducting. A retaining pin shall be inserted in the handle and an eyelet on the clamp as a safety feature to ensure the handle does not prematurely come undone.
 2. Approved caulk is 3M Scotch Seal Metal Sealant 2084 or equivalent for system temperatures of 250°F or lower.
 3. Sealing O-rings shall be Buna-N, ASTM D2000 MBC610, 60 Durometer Hardness, with a temperature rating of 250°F maximum and is black in color, used with the adjustable nipple.
 4. Sealing gaskets shall be molded and shall meet the material classification of ASTM D-2000 M2BG510 A24 B34 EO14 EO34 EF11 EF21 and used in systems where the temperature rating is 225°F or less and are black in color. This component shall be made using conductive materials for conductivity.
 5. Sponge O-ring shall meet the material classification of either ASTM D-1056-68 – SBE43 or ASTM D1056-85, 91, 98 – 2B3
 6. Clamp seals shall be Nitrile to meet or exceed ASTM D1056 2B2 standards with a temperature rating not to exceed 158°F constant temperature (or intermittent temperature of 194°F).
- D. Metal-to-metal contact shall be obtained at all joint connections. Die-formed rolled edges are uniform in shape to provide the most consistent contact. The ears of the clamp contact with the rolled edges and provide maximum conductivity. Conductivity shall be adhered to per NFPA 77 paragraph 8.4.1.1; states all parts of the continuous metal piping system should have a resistance level that does not exceed 10 ohms. Contractor shall field test resistivity.
- E. Dust collection ductwork shall be Nordfab Quick-Fit pipe or approved equivalent. Layout shall be factory designed and submit as shop drawing.

2.4 DUST COLLECTOR ACCESSORIES

- A. Blast Gates: Manual full blast gates shall have aluminum or stainless-steel body and stainless steel or galvanized sliding door with thumb turn lock screw. Blast gate opening shall equal duct size.
- B. Floor sweeps: Provide factory manufactured floor sweeps with foot operated lever for opening door.
- C. Equipment connections: Provide factory equipment connections for items noted on the drawings. Field verify connection size and specific connection required for each piece of equipment.

PART 3 -

END OF SECTION 24 35 00

SECTION 24 37 00 – AIR DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air Diffusers
 - a. Louvered face ceiling diffusers
 - b. Square plaque face diffusers
 - c. Linear bar diffusers
 - d. Slot diffusers
 - e. Architectural continuous linear slot diffusers
 - f. Jet diffuser with reversible nozzle
2. Grilles, registers and diffusers
 - a. Sidewall return/supply grilles- reversible core
 - b. Heavy duty sidewall return grilles

B. Furnish and install diffusers, grilles, and registers as shown on the drawings and specified herein.

1.2 ACTION SUBMITTALS

A. Submittal data for all distribution devices shall contain the following information:

1. Room Number
2. Model Number
3. Flow Rate
4. Size: Neck and where applicable
5. Throw in feet: Based on 50-fpm velocity
6. Air patterns: Such as one-way, two-way opposite, corner, four-way, etc.
7. Pressure drop in inches of water
8. Sound rating
9. Airflow factor: Such as K factor or as required for airflow rate measurements.
10. Accessories: Such as volume dampers, deflectors, etc.
11. Three-color charts and balance instructions shall be furnished with submittal data.

B. Ceiling diffusers shall be of the type, service, size, and finish as scheduled on the drawings. Border types shall be coordinated by the Contractor to be suitable for ceiling types grid width, tile types, drywall, plaster, concealed spline) in which diffusers will be installed.

1.3 INFORMATIONAL SUBMITTALS

A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Devices described herein and indicated on the drawings are based on Titus. Approved equal selections by the following manufacturers will also be acceptable. Such equipment substitutions shall be evaluated on the basis of equivalent performance parameters of throw, pressure drop, and maximum noise criterion (NC). Return or exhaust devices shall not be smaller than sizes shown.
 - 1. AJ Manufacturing Co., Inc.
 - 2. Anemostat
 - 3. Carnes
 - 4. Krueger
 - 5. Metalaire
 - 6. Nailor
 - 7. Price
 - 8. Titus
 - 9. Tuttle & Bailey

2.3 LOUVERED CEILING DIFFUSERS

- A. Material: [Steel] [Aluminum] [Stainless Steel] [As scheduled]
- B. Finish: [Baked enamel, white] [Baked enamel, color selected by Architect] [Anodized aluminum] <Insert finish>
- C. Face Size: As scheduled
- D. Construction:
 - 1. An outer frame assembly
 - 2. An integral collar that allows connection to a square or round duct as scheduled
 - 3. An inner core assembly consisting of fixed louvers capable of producing the airflow discharge pattern as indicated on the project plans, and shall be fully removable from the installed diffuser frame for access to any dampers or other ductwork components located in or near the diffuser neck.
 - 4. [In wet areas air devices shall be aluminum construction.]

- E. Mounting:
 - 1. The diffuser shall be supplied with a frame suitable for mounting in the lay-in ceiling system (see architectural).
 - 2. Where installed in a drywall ceiling, a lift-out plaster / drywall frame shall be provided.
- F. Accessories:
 - 1. [Adjustable pattern deflectors]
 - 2. [Clips to positively attached lay-in air devices to the ceiling system]
 - 3. [Safety chain]
 - 4. [Fire rated construction with fusible link rated for] [165 °F] [212 °F]
 - 5. [Aperture style flow damper that is room-side adjustable]
 - 6. [Diffuser back pan shall be externally insulated with R-6 insulation containing a heavy duty foil / scrim vapor barrier. Insulation shall meet the requirements of UL 181 and NFPA 90A.]

2.4 SQUARE PLAQUE DIFFUSER

- A. Material: [Steel] [Aluminum] [Stainless Steel] [As scheduled]
- B. Finish: [Baked enamel, white] [Baked enamel, color selected by Architect] [Anodized aluminum] <Insert finish>
- C. Face Size: As scheduled
- D. Construction:
 - 1. Diffusers shall consist of a seamless, one-piece, precision formed back cone with no corner joints that incorporates a round inlet collar of sufficient length for connecting rigid or flexible duct.
 - 2. The diffuser shall integrate with all duct sizes shown on the plans without affecting the face size and appearance of the unit.
 - 3. An inner plaque assembly shall be incorporated and configured to assure proper air distribution performance.
 - 4. The inner plaque assembly shall be completely removable from the room side to allow for full access to any dampers or other ductwork components located near the diffuser neck.
 - 5. [In wet areas air devices shall be aluminum construction.]
- E. Mounting:
 - 1. The diffuser shall be supplied with a frame suitable for mounting in the lay-in ceiling system (see architectural).
 - 2. Where installed in a drywall ceiling, a lift-out plaster / drywall frame shall be provided.
- F. Accessories:
 - 1. [Air baffles]
 - 2. [Clips to positively attached lay-in air devices to the ceiling system]
 - 3. [Safety chain]
 - 4. [Fire rated construction with fusible link rated for] [165 °F] [212 °F]
 - 5. [Butterfly style flow damper that is room-side adjustable]

6. [Diffuser back pan shall be externally insulated with R-6 insulation containing a heavy duty foil / scrim vapor barrier. Insulation shall meet the requirements of UL 181 and NFPA 90A.]

2.5 LINEAR BAR DIFFUSERS

- A. Material: [Steel] [Aluminum] [Stainless steel].
- B. Finish: [Baked enamel, white] [Baked enamel, color selected by Architect] <Insert finish>.
- C. Retain one of first five paragraphs below.
- D. Narrow Core Spacing Arrangement: 1/8-inch- (3-mm-) thick blades spaced 1/4 inch (6 mm) apart; [zero] [15]-degree deflection.
- E. Wide Core Spacing Arrangement: 1/8-inch- (3-mm-) thick blades spaced 1/2 inch (13 mm) apart; [zero] [15]-degree deflection.
- F. Wide Core Spacing Arrangement: 3/16-inch- (5-mm-) thick blades spaced 1/2 inch (13 mm) apart; [zero] [15] [30]-degree deflection.
- G. Pencil-Proof Core Spacing Arrangement: 3/16-inch- (5-mm-) thick blades spaced 7/16 inch (11 mm) apart; [zero] [15] [30]-degree deflection.
- H. [One] [Two]-Way Deflection Vanes: Extruded construction [fixed] [adjustable] louvers with removable core.
- I. Frame: [1-1/4 inches (32 mm)] [1 inch (25 mm)] [3/4 inch (19 mm)] [1/2 inch (13 mm)] [3/16 inch (5 mm)] wide.
- J. Retain first paragraph below if mounting frame is required.
- K. Mounting Frame: [Filter] <Insert frame size and style>.
- L. Mounting: [Countersunk screw] [Concealed bracket] [Spring clip].
- M. Damper Type: [Adjustable opposed-blade assembly] [Hinged single blade].
- N. Accessories: [Plaster frame] [Directional vanes] [Alignment pins] [Core clips] [Blank-off strips].

2.6 SLOT DIFFUSERS

- A. Material: [Steel] [As scheduled]
- B. Plenum: [Insulated] [Uninsulated]
- C. Finish - Face and Shell: [Baked enamel, black] <Insert finish>.
- D. Finish - Pattern Controller: [Baked enamel, black] <Insert finish>.

- E. Finish - Tees: [Baked enamel, white] [Baked enamel, color selected by Architect] <Insert finish>.
- F. Slot Quantity / Width: [As scheduled]
- G. Length: [As scheduled]
- H. Accessories
 - 1. [Plaster frame] [T-bar slot] [Center notch] [T-bar on inlet side] [T-bar on both sides] [T-bar clip on one side] [T-bar clips on both sides]
 - 2. [Clips to positively attached lay-in air devices to the ceiling system]
 - 3. [Safety chain]

2.7 ARCHITECTURAL CONTINUOUS LINEAR SLOT DIFFUSERS

- A. Material: Aluminum, 0.062 inches thick.
- B. Plenum: Supply: Field fabricated, Insulated; Return: factory return hood/light shield, uninsulated.
- C. Finish - Face: Baked enamel, white <Insert finish>.
- D. Finish - Pattern Controller: Baked enamel, black]<Insert finish>.
- E. Slot Quantity / Width: [As scheduled]
- F. Length: [As scheduled]
- G. Accessories
 - 1. [Plaster frame]] [T-bar clip on one side] [T-bar clips on both sides]
 - 2. [Clips to positively attached lay-in air devices to the ceiling system]
 - 3. [Safety chain]
- H. Basis of Design: Titus Flowbar

2.8 JET DIFFUSER WITH REVERSIBLE NOZZLE

- A. Material: [Steel] [Aluminum]
- B. Finish: [Baked enamel, white] [Baked enamel, color selected by Architect] [Anodized aluminum] <Insert finish>
- C. Size: As scheduled
- D. Construction:
 - 1. Welded construction
 - 2. Air outlet shall have a reversible core allowing for either a jet or diffuse discharge.
 - 3. The axis of the air discharge may be varied by up to 30° from the straight forward in a full 360° arc.

- E. Mounting
 - 1. [The air outlet shall be attached to a sidewall mounting panel with mounting screws permitting a 360° rotation.]
 - 2. [The air outlet shall be mounted at the end of a round spiral duct.]
- F. Accessories
 - 1. [Opposed blade volume damper]
- G. Anemostat DJ series, no substitutions.

2.9 SIDEWALL RETURN/SUPPLY GRILLES- REVERSIBLE CORE

- A. Material: Aluminum
- B. Finish: [Baked enamel, white] [Baked enamel, color selected by Architect] [Anodized aluminum] <Insert finish>
- C. Size: As scheduled
- D. Construction:
 - 1. The grille shall have multiple deflection fixed louver type blades.
 - 2. Grilles blades and frame shall be extruded aluminum construction.
 - 3. The grille core shall be field removable from the frame to facilitate inversion or reversing to modify the discharge deflection.
 - 4. The core shall be held into the frame with steel spring clips.
 - 5. The grilles blade orientation shall run parallel to the [long] [short] dimension.
- E. Mounting:
 - 1. The grille shall be supplied with a 1" [flat border mounting frame] [curved mounting frame]
 - 2. The grille shall be configured for [Countersunk screw] [Concealed] [Lay in] fastening.
- F. Accessories:
 - 1. Directional blades
 - 2. [Steel opposed blade damper] [Aluminum opposed blade damper] [operable from the diffuser face]

2.10 HEAVY DUTY SIDEWALL RETURN GRILLES

- A. Material: [Steel] [Aluminum] [Stainless Steel] [As scheduled]
- B. Finish: [Baked enamel, white] [Baked enamel, color selected by Architect] [Anodized aluminum] <Insert finish>
- C. Size: As scheduled
- D. Construction:
 - 1. Grille shall be fixed louvers blades with [3/8"] [1/2"] spacing at a [0°] [30°] [38°] [45°] <insert angle> deflection.

2. Blades shall be parallel with the [long] [short] dimension.
- E. Mounting
1. The grille shall be supplied with a 1¼" flat frame with smooth corners.
 2. The grille shall be configured for [Countersunk screw] [Concealed] [Lay in] fastening.
- F. Accessories
1. [Steel opposed blade damper] [Aluminum opposed blade damper] [operable from the diffuser face]
 2. The grille shall be supplied with a frame that will accept a standard [one inch] or [two inch] filter. Filter media shall be supplied by others.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Air devices shall be installed in the location, orientation and the pattern controllers adjusted as indicated on the plans.
- B. Air devices shall be installed in compliance with manufacturers' requirements.
- C. Install air diffusers with air-tight connections to ductwork.

3.3 ADJUSTING

- A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

3.4 CLEANING AND PROTECTION

- A. Clean air devices at project completion.

END OF SECTION 24 37 00

SECTION 24 41 00 – FILTER ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pleated panel filters
2. V-Bank cell filters
3. Supported bag filters
4. Back-access filter frames
5. Side-access filter housings
6. Filter gauges

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. ASHRAE Compliance as noted herein.
- C. Comply with UL 900

2.2 PLEATED PANEL FILTERS

- A. 2" and 4" filters shall be dust spot efficiency on ASHRAE Test Standard 52.1 and MERV 8 on ASHRAE Test Standard 52.2. The filter media shall be a self-extinguishing, non-woven cotton and synthetic fabric, UL Class 2. The enclosing frame shall be a rigid, heavy duty, moisture resistant, high wet strength beverage board die cut for dimensional accuracy with diagonal support members. The pleated media pack shall be bonded to the inside of the frame on all four edges to prevent leakage. The media support shall be a welded wire grid bonded to the filter media to reduce media oscillation. The media support shall be contoured shape allowing total use of the filter media for longer life.
1. 2" filters shall not have less than 14 pleats per linear foot and not less than 17 square feet of effective media (based on 24" x 24"). Filters shall be as manufactured by Camfil-Farr Filter model 30/30, American Air Filter model 300X, or approved equivalent.
 2. 4" filters shall not have less than 21 pleats per linear foot and not less than 27 square feet of effective media (based on 24" x 24"). Filters shall be as manufactured by Camfil-Farr Filter model 30/30, American Air Filter model 300X, or approved equivalent.

2.3 PLEATED PANEL FILTERS [HIGHER MERV RATING]

- A. 4" filters shall be dust spot efficiency on ASHRAE Test Standard 52.1 and MERV 13 on ASHRAE Test Standard 52.2. The filter media shall be a self-extinguishing, non-woven cotton and synthetic fabric, UL Class 2. The enclosing frame shall be a rigid, heavy duty, moisture resistant, high wet strength beverage board die cut for dimensional accuracy with diagonal support members. The pleated media pack shall be bonded to the inside of the frame on all four edges to prevent leakage. The media support shall be a welded wire grid bonded to the filter media to reduce media oscillation. The media support shall be contoured shape allowing total use of the filter media for longer life.
1. 4" filters shall not have less than 9 pleats per linear foot and not less than 22 square feet of effective media (based on 24" x 24"). Filters shall be as manufactured by Camfil-Farr Filter model Aeropleat 13, American Air Filter model PREPleat M13, or approved equivalent.

2.4 LOW PRESSURE DROP EXTENDED MEDIA FILTERS

- A. Filters shall be high efficiency extended media disposable type. Filter media shall be microfine glass formed into a uniformly spaced pleats separated by fiberglass thread separators and formed into a minipleat pack design. Filters shall be rated as UL Class 2.
1. 22" deep 65% dust spot efficiency on ASHRAE Test Standard 52.1 and MERV 11 on ASHRAE Test Standard 52.2. Filters shall have not less than 70 square feet of effective media based on 24" x 24" size. Filters shall be as manufactured by Camfil-Farr Filter model Hi-Flo ES or approved equivalent.
 2. 15" deep 65% dust spot efficiency on ASHRAE Test Standard 52.1 and MERV 11 on ASHRAE Test Standard 52.2. Filters shall have not less than 70 square feet of effective media based on 24" x 24" size. Filters shall be as manufactured by Camfil-Farr Filter model Hi-Flo ES or approved equivalent.
 3. 12" deep 65% dust spot efficiency on ASHRAE Test Standard 52.1 and MERV 11 on ASHRAE Test Standard 52.2. Filters shall have not less than 70 square feet of effective

media based on 24" x 24" size. Filters shall be as manufactured by Camfil-Farr Filter model Hi-Flo ES or approved equivalent.

2.5 V-BANK CELL FILTERS

- A. Second stage filters shall be high-efficiency pleat-in-pleat V-bank disposable type. Filter media shall be microfine glass formed into uniformly spaced pleats separated by fiberglass thread separators and formed into a minipleat pack design. Each minipleat pack shall be assembled into a V-bank configuration. Filter shall be rated as UL Class 2.
1. 12" deep 65% dust spot efficiency on ASHRAE Test Standard 52.1 and MERV 11 on ASHRAE Test Standard 52.2. Filters shall have not less than 200 square feet of effective media based on 24" x 24" size. Filters shall be as manufactured by Camfil-Farr Filter model Durafil ES, American Air Filter model VariCel VXL, or approved equivalent.
 2. 12" deep 95% dust spot efficiency on ASHRAE Test Standard 52.1 and MERV 14 on ASHRAE Test Standard 52.2. Filters shall have not less than 200 square feet of effective media based on 24" x 24". Filters shall be as manufactured by Camfil-Farr model Durafil ES, American Air Filter model VariCel VXL, or approved equivalent.

2.6 BACK-ACCESS FILTER FRAMES

- A. Description: [Galvanized-steel] framing members with access for downstream (back) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with filter installation or operation.
1. The housing shall be manufactured of a minimum of 16 [14] ga. reinforced galvanized steel.
 2. ¾-inch filter sealing flange to assure proper filter seating and sealing.
 3. [1" absolute sealing flange to ensure an airtight filter gasket to frame seal.]
 4. Polyurethane gasketing on the frame to filter sealing surface to assure leak-free performance.
- B. Prefilters: Incorporate a separate track[with spring clips], removable from front[or back].
- C. Sealing: Factory-installed, positive-sealing device for each row of filters, to ensure seal between gasketed filter elements and to prevent bypass of unfiltered air.
- D. AAF Type A-8, Camfil Type 8, or approved equivalent
- E. [AAF A-4, Camfil MagnaFrame II, or approved equivalent.]

2.7 SIDE-ACCESS FILTER HOUSINGS

- A. Housing shall be a complete factory assembled housing with upstream and downstream outwardly turned flanges for insertion into the ductwork system. The housing shall be manufactured of a minimum of 16 ga. reinforced galvanized steel. Access doors with continuous gasketing on the perimeter shall be provided at both ends of the housing. When an access door is

opened, the filter cartridges shall be slid into the housing where they shall be retained on slide channels. These channels shall incorporate a positive-sealing gasket material to seal the top and bottom of the filter cartridge frames to prevent bypass. Leakage shall be prevented between cartridges, and between cartridges and doors, by factory installed gasketing. Positive-latching handles will seal the access doors to the housing. Filter cartridges shall be capable of being loaded or unloaded through either access door.

- B. Housings for 4" filters shall be 12" housing depth as manufactured by Camfil-Farr Filter model 4P Glide/Pack, Flanders/Air Seal model FL4, American Air Filter model Polyseal, or approved equivalent.

2.8 FABRICATED FILTER HOUSINGS

- A. Housing shall be a shop fabricated filter housing and built to house 4" [2"] filters and shall have upstream and [downstream] outwardly turned flanges for insertion into the ductwork system or equipment. The housing shall be manufactured of a minimum of 16 ga. reinforced galvanized steel. Access doors with continuous gasketing on the perimeter shall be provided at both ends of the housing. When filter access is on the side the filter cartridges shall be slid into the housing where they shall be retained on slide channels. When filter access is on the top of the housing the filter cartridges shall be slid into the housing where they shall be retained on slide channels. These channels shall incorporate a positive-sealing gasket material to seal the top and bottom of the filter cartridge frames to prevent bypass. Filter cartridges shall be capable of being loaded or unloaded through either the top or the side.

2.9 FILTER GAUGES

- A. Each filter assembly shall have a gauge arranged to measure pressure across each filter type in housings containing more than one filter. Provide all necessary pressure taps, tubing, fittings, valves, and mounting hardware. Gauges shall be Dwyer Model 2001 or equivalent (0-1" range for single stage 30% filters) (0-2" range for 65% or greater filters or multiple stages). Each filter assembly shall have an engraved plastic plate indicating what the final change-out pressure is for each type of filter.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Filters shall be installed before running any equipment (temporary or permanent).
- B. Inspect equipment to ensure that cleaning has been completed before filters are installed.

3.2 INSTALLATION

- A. For duct mounted filter housings assemblies provide access doors upstream [and downstream] of the duct filters.
- B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- C. Install filters in position to prevent passage of unfiltered air.
- D. Filters shall be replaced prior to balancing.
- E. Install filter gauge for each filter bank.
- F. Install filter-gauge, static-pressure taps upstream and downstream from filters. Install filter gauges on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gauges on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gauges.

3.3 CLEANING AND PROTECTION

- A. Final filters shall not be installed until units, filter housings, and ductwork have undergone a filter cleaning process to remove construction debris.

END OF SECTION 24 41 00

SECTION 25 00 00 – TEMPERATURE CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provisions and conditions cited in this Section shall apply to Work for other sections of Divisions 25 of these Specifications.
 - 1. Section 25 10 00 – Control System Requirements
 - 2. Section 25 20 00 – Airside Control Equipment
 - 3. Section 25 30 00 – Hydronic Control Equipment
 - 4. Section 25 40 00 – Auxiliary Equipment
 - 5. Section 25 50 00 – Wiring Materials and Methods
- C. The following sections of the Specifications apply to Work under this Section
 - 1. Section 01 91 13 – Commissioning of Building Systems
 - 2. Division 20 - Basic Mechanical Conditions and Basic Mechanical Material and Methods
 - 3. Division 22 – Plumbing work
 - 4. Division 23 – HVAC Piping and Equipment
 - 5. Division 24 – Air Distribution
 - 6. Division 26 – Electrical
 - 7. Division 27 – Communications

1.2 SUMMARY

- A. This Section specifies an Automation/Energy Management System to control and monitor HVAC systems.

1.3 REFERENCES

- A. Applicable requirements of the current and accepted edition of the following industry standards, codes and specifications shall apply to the Work for Division 25
 - 1. ASHRAE 36 – High-Performance Sequences of Operation for HVAC Systems
 - 2. ASHRAE DDC Standard
 - 3. ASHRAE Standard 135-2016, BACnet – A Data Communication Protocol for Building Automation and Control Networks.
 - 4. BACnet Testing Laboratories (BTL) for product testing and certification.
 - 5. FCC rules, Part 15, Subpart J, regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.
 - 6. NFPA 70 – National Electrical Code
 - 7. Project Haystack open source building data semantic tagging model.

8. UL 864 Underwriters Laboratories Standard for Standard for Control Units and Accessories for Fire Alarm Systems
9. UL 916 Underwriters Laboratories Standard for Energy Management Equipment.
10. Xeto

1.4 DEFINITIONS

- A. Adjustable (Adj.): Where used in this Section of the Specifications shall be defined as values that are adjustable at the GUI without the need for any software. This adjustment may be password protected to limit access to an appropriate user level and may use an adjustment mechanism similar to point overrides.
- B. Control Loop or Loop: Used generically for all control loops. These will typically be PID loops, but proportional plus integral plus derivative gains are not required on all loops. Unless specifically indicated otherwise, the guidelines in the following subsections shall be followed.
- C. Control Wiring: All wiring, 120 VAC line voltage or lower other than power wiring, required for the proper operation of the mechanical system and the BAS. This includes applications where line voltage serves as the control circuit such as a line voltage thermostat or involves interlocking with a damper.
- D. Deadband: The difference between two setpoint or configuration values during which no output function is performed.
- E. Dewpoint Temperature or Dewpoint: The saturation temperature of water in moist air, as evidenced by the temperature at which water will condense out of air. Dewpoint temperature is an evaluation of the absolute water content of moist air, so for control applications, it is used where moisture content of air needs to be maintained, such as humidification or dehumidification processes.
- F. Differential: The range or units of measure that separate the enable point from the disable point.
- G. DDC or Direct Digital Control: A control technique through which the process variable is continuously monitored by a digital computer which accomplishes loop control by calculating a control solution for output to a control device.
- H. Discharge Temperature: The temperature discharged from a piece of equipment, but not necessarily to an end use consumer.
- I. EMS Energy Management System, BAS Building Automation System: May be used interchangeably in this Section of the Specifications to mean a system to control mechanical equipment using DDC. This definition includes both hardware and software components that are integrated to form a working system.
- J. Enthalpy: The psychrometric quantity equivalent to the total heat content of air. It is usually used to evaluate if the outside air contains less heat than the return air and determine whether to enable economizer.
- K. Hard Wired Control: A control method using relays to enable and interrupt signals without the use of a controller.

- L. Proportional: A set of signals that vary in a continuously linear relationship with each other. They may be direct or reverse acting.
- M. Power Wiring: All line voltage wiring to the mechanical and BAS equipment that is required for proper operation of the equipment. Typically, this wiring will support voltage at or above 120 VAC and is connected to the equipment for the purpose of providing motive power.
- N. Proven (i.e., “proven ON”/“proven OFF”): The equipment’s DI status point (where provided, e.g., current switch, DP switch, or VFD status) matches the state set by the equipment’s DO command point.
- O. Relative Humidity: The psychrometric property that is an evaluation of how much water vapor is present in air relative to the capacity of air at the current temperature and pressure to hold water. While it is a good measure of comfort levels, the temperature dependence of this value can make it an unstable control variable.
- P. Software Point: An analog variable, and “software switch” shall mean a digital (binary) variable, that are not associated with real I/O points. They shall be read/write capable (e.g., BACnet analog variable and binary variable).
- Q. Supply Temperature: The temperature supplied to an occupied zone or terminal equipment point of use.
- R. Temperature: The psychrometric value dry bulb temperature.
- S. Wet Bulb Temperature: The psychrometric property wet bulb temperature is the equilibrium temperature at which liquid water evaporates into the air at saturation. It can be measured with a thermometer that has a wick saturated in water. For control processes, it is typically used for the control of cooling towers since it is related to the evaporation of water in air. This is a different value from dewpoint temperature.
- T. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.
- U. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.
- V. BACnet Specific Definitions:
 - 1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data and services over a network.
 - 2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
 - 3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
 - 4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.

- W. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.
- X. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: network controllers, programmable application controllers, and application-specific controllers.
- Y. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.
- Z. COV: Changes of value.
- AA. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.
- BB. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems to be capable of operating in a standalone mode using the last best available data.
- CC. E/P: Voltage to pneumatic.
- DD. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- EE. HLC: Heavy load conditions.
- FF. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI) and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.
- GG. I/P: Current to pneumatic.
- HH. LAN: Local area network.
- II. LNS: LonWorks Network Services.
- JJ. LON Specific Definitions:
1. FTT-10: Echelon Transmitter-Free Topology Transceiver.
 2. LonMark International: Association comprising suppliers and installers of LonTalk products. Association provides guidelines for implementing LonTalk protocol to ensure interoperability through a standard or consistent implementation.
 3. LonTalk: An open standard protocol developed by Echelon Corporation that uses a "Neuron Chip" for communication. LonTalk is a register trademark of Echelon.
 4. LonWorks: Network technology developed by Echelon.

5. Node: Device that communicates using CTA-709.1-D protocol and that is connected to a CTA-709.1-D network.
 6. Node Address: The logical address of a node on the network, consisting of a Domain number, Subnet number, and Node number. "Node number" portion of an address is a number assigned to device during installation, is unique within a subnet, and is not a factory-set unique Node ID.
 7. Node ID: A unique 48-bit identifier assigned at factory to each CTA-709.1-D device. Sometimes called a "Neuron ID."
 8. Program ID: An identifier (number) stored in a device (usually, EEPROM) that identifies node manufacturer, functionality of device (application and sequence), transceiver used, and intended device usage.
 9. Standard Configuration Property Type (SCPT): Pronounced "skip-it." A standard format type maintained by LonMark for configuration properties.
 10. Standard Network Variable Type (SNVT): Pronounced "snivet." A standard format type maintained by LonMark used to define data information transmitted and received by individual nodes. "SNVT" is used in two ways. It is an acronym for "Standard Network Variable Type" and is often used to indicate a network variable itself (i.e., it can mean "a network variable of a standard network variable type").
 11. Subnet: Consists of a logical grouping of up to 127 nodes, where logical grouping is defined by node addressing. Each subnet is assigned a number, which is unique within a Domain. See "Node Address."
 12. TP/FT-10: Free Topology Twisted Pair network defined by CTA-709.3 and is most common media type for a CTA-709.1-D control network.
 13. TP/XF-1250: High-speed, 1.25 Mbps, twisted-pair, doubly terminated bus network defined by "LonMark Interoperability Guidelines" and typically used only to connect multiple TP/FT-10 networks.
 14. User-Defined Configuration Property Type (UCPT): Pronounced "u-keep-it." A Configuration Property format type that is defined by device manufacturer.
 15. User-Defined Network Variable Type (UNVT): Network variable format defined by device manufacturer. UNVTs create non-standard communications that other vendors' devices may not correctly interpret and may negatively impact system operation. UNVTs are not allowed.
- KK. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- LL. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.
- MM. Modbus TCP/IP: An open protocol for exchange of process data.
- NN. MS/TP: Master-slave/token-passing, ISO/IEC/IEEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
- OO. MTBF: Mean time between failures.
- PP. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

- QQ. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
- RR. Peer to Peer: Networking architecture that treats all network stations as equal partners.
- SS. POT: Portable operator's terminal.
- TT. RAM: Random access memory.
- UU. RF: Radio frequency.
- VV. Router: Device connecting two or more networks at network layer.
- WW. Server: Computer used to maintain system configuration, historical and programming database.
- XX. TCP/IP: Transport control protocol/Internet protocol.
- YY. UPS: Uninterruptible power supply.
- ZZ. USB: Universal Serial Bus.
- AAA. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.
- BBB. VAV: Variable air volume.
- CCC. WLED: White light emitting diode.

1.5 QUALITY ASSURANCE

- A. Work for this Section of the Specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Division 20.
- B. All operable devices and features of the BAS, accessories, equipment and specialties provided for in the Scope of Work of this Section shall be operated and proved to function satisfactorily for a period of number (x) days. Adjust, balance, lubricate as required, and instruct the Owner in the proper operation and maintenance of each device.
- C. Equipment and devices shall be protected against damage in the period between installation and acceptance. Any item damaged shall be removed, repaired and/or replaced at no additional compensation.

1.6 CLOSEOUT SUBMITTALS

- A. Refer to General Conditions and Division 20.
- B. As-built drawings of electrical circuit numbers, power panels.....

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 25 00 00

SECTION 25 10 00 – CONTROL SYSTEM REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Automation/Energy Management System to control and monitor HVAC systems.
- B. Related Requirements:
 - 1. Section 25 00 00 TEMPERATURE CONTROL SYSTEM

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.
- B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Automated Logic, Allerton, Johnson Controls Metasys, Trane
- B. _____ factory branch office, no substitutions allowed.

2.3 ENTERPRISE SERVER HARDWARE

- A. An application server on the Owner's enterprise IT infrastructure will be used to host the Enterprise Server application for the project. The Owner will create a virtual machine on one of their existing servers, and this contractor will be granted remote access permissions to install and administer the Enterprise Server application for this contract.
- B. Web server or workstation shall have an industry-standard professional-grade operating system. Operating system shall meet or exceed the DDC System manufacturers minimum requirements for their software. Provide sufficient internal memory for the specified sequences of operation and trend logging. The contractor is responsible for supplying all hardware, software, configuration, maintenance, including security for the application server.

2.4 ENTERPRISE SERVER SOFTWARE

- A. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.
 - 1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
 - 2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
 - 3. For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.
 - 4. System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.

- B. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.
1. Automatic System Database Configuration: Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
 2. Manual Controller Memory Download: Operators shall be able to download memory from the system database to each controller.
 3. System Configuration: The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection. Operators shall be able to configure the system.
 4. On-Line Help: Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
 5. Security: Each operator shall be required to log on to the system with user name and password in order to view, edit, add, or delete data.
 - a. Operator Access: The user name and password combination shall define accessible viewing, editing, adding, and deleting privileges for that operator. Users with system administrator rights shall be able to create new users and edit the privileges of all existing users. System Administrators shall also be able to vary and deny each operator's privileges based on the geographic location of the equipment, such as the ability to edit operating parameters in Building A, to view but not edit parameters in Building B, and to not even see equipment in Building C.
 - b. Automatic Log Out: Automatically log out each operator if no keyboard or mouse activity is detected. This auto logoff time shall be user adjustable.
 - c. Encrypted Security Data: Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
 - d. System Diagnostics: The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the operator.
- C. The Enterprise Server shall contain licensing required for all system hardware and software needed to fulfill the requirements of the plans and specifications. This includes, but is not limited to: Point counts, connected controllers, RS-485 network drivers, TCIP/IP network drivers, third party integration protocols.
- D. Alarm Processing: System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
- E. Alarm Messages: Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms or mnemonics.

- F. Alarm Reactions: Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm. As a minimum, the workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
- G. Alarm and Event log: Operators shall be able to view all system alarms and changes of state from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and delete alarms, and archive closed alarms to the workstation or web server hard disk.
- H. Trend Logs: The operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Trends shall be BACnet trend objects.
- I. Object and Property Status and Control: Provide a method for the operator to view, and edit if applicable, the status of any object or property in the system. The status shall be available by menu, on graphics, or through custom programs.
- J. Clock Synchronization: Provide open-protocol time synchronization service for all controllers on the connected network. The system shall automatically synchronize system clocks daily via the distributed network. The system shall automatically adjust for daylight savings and standard time as applicable.
- K. Reports and Logs: Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
- L. Standard Reports: Furnish the following standard system reports:
 - 1. Objects: System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
 - 2. Alarm Summary: Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
 - 3. Logs: System shall log the following to a database or text file and shall retain data for an adjustable period:
 - a. Alarm History.
 - b. Trend Data: Operator shall be able to select trends to be logged.
 - c. Operator Activity: At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.
- M. Workstation Application Editors: Each browser workstation shall support editing of all system applications. The applications shall be downloaded and executed at one or more of the controller panels.
 - 1. Controller: Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.
 - 2. Scheduling: An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and schedule type. Exception schedules

and holidays shall be shown clearly on the calendar. The start and stop times for each object shall be adjustable from this interface.

3. Custom Application Programming: Provide the tools to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
 - a. Language: Language shall be graphically based or English language oriented. If graphically based, language shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks.
 - b. A full-screen character editor programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate features such as cut/ paste and find.
 - c. The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.
 - d. The programming language shall support conditional statements (IF/THEN/ELSE/ ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - e. The programming language shall support floating-point arithmetic using the following operators: +, -, ×, and square root. The following mathematical functions also shall be provided: absolute value and minimum/maximum value.
 - f. The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval-timing functions can be stopped and started within a program.
 - g. The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.

2.5 BUILDING CONTROLLERS (BC)

- A. Building Controllers (BC) shall be capable of being networked on a peer to peer network with other Building Controllers as well as being networked to a campus Ethernet LAN as standard or through an additional communication module. The supporting firmware and hardware shall be configured and arranged so that a dedicated LAN is not required for networking of the system controllers. In other words, the system shall be capable of interfacing with an existing Ethernet LAN which is on line and handling communications between other data systems, and using this LAN for handling its own inter controller communications without interference from or interference to the original communications occurring on the network. Having only a proprietary communications bus available at this level will be unacceptable. The files and data transferred on the network may be proprietary and use proprietary file and data string structures. The minimum communication rate shall be 100 Mbps.
- B. Building Controllers shall function as communications/network controllers supporting both communications to other Building Controllers on a high level, high speed bus as well as communications to Custom Application Controllers (CAC) and Application Specific Controllers

(ASC) on lower level Local Area Networks (LANs). The following specific functions shall be required.

1. Provide an adequate number of BC to achieve the performance specified in “BAS PERFORMANCE.”
2. The BC shall have sufficient memory to support its operating system, database, and programming requirements.
3. Controllers that perform scheduling shall have a real-time clock.
4. Support for a high level communications using Ethernet, or other high-speed protocol. The files and data transferred on the network may be proprietary and use proprietary file and data string structures. The minimum communication rate shall be 100 Mbps. High level communications will reside on Tier 2 communications.
5. Support for a low-level communications bus or busses for communications between lower level controllers such as Custom Application Controllers, Application Specific Controllers, and Third Party Devices. Low level communications will be Tier 3 communications.
 - a. Custom Application Controllers are stand-alone controllers that are fully custom programmable.
 - b. Application Specific Controllers are small, low point density, low memory stand-alone controllers with pre-programmed sequences geared to a very specific application lacking in the ability to do custom control sequences but providing “fill in the blank” programming simplicity. Controllers are suitable for use in controlling terminal equipment such as reheat coils, constant volume regulators, variable volume boxes, fan coil units, fan terminal units, etc.
 - c. Third Party Devices include Variable Frequency Drives, Chillers, Boiler Control Panels, Lighting Control Systems, and other devices included in the specifications that share information with the DDC system. At the contractor’s option, Third Party Devices may be isolated by a BACnet MS/TP router. In that instance, the router and all configuration shall be provided by this contractor.
 - d. The low level communications bus shall be BACnet MS/TP utilizing TIA-485. Minimum communications speed shall be 19,200 baud. Low level communications bus networks utilizing LonWorks, Modbus, or proprietary protocols shall be clearly identified in the submittal process and are subject to review and acceptance.
6. Each Building Controller shall perform the following energy management routines as a minimum:
 - a. Event based programming
 - b. Time of day programming
 - c. Optimized time of day programming
 - d. Demand control
 - e. Duty Cycling
 - f. Global data sharing (one point used by multiple controllers)
 - g. Programmable schedule overrides
 - h. Scheduling
 - i. Hours of operation accumulation
 - j. Reporting
 - k. Trending
 - l. Alarming
 - m. Time synchronization of controllers
 - n. Customized start-up on power failure

7. Each Building Controller shall perform customized control strategies based upon arithmetic, Boolean or time delay logic. The arithmetic functions shall permit simple relationships between variables as well more complex relationships (i.e., square root, exponential). The system shall permit the generation of job specific control strategies that can be activated in any of the following ways:
 - a. Continuously
 - b. At a particular time of day
 - c. On a pre defined date
 - d. When a specific measured or controlled variable reads a selected value or state
 - e. When a piece of equipment has run for a certain period of time
8. Upon a loss of commercial power to any Building Controller, the other units within the network shall not be affected, and the loss of operation of that unit shall be reported at the designated operator's terminal. All control strategies and energy management routines defined for the BC shall be retained during a power failure with the unit. Upon resumption of commercial power, the control unit shall resume full operation without operator intervention including updating all monitored functions, resume operation based on synchronized time and status, and custom start-up strategies.
 - a. Each Building Controller shall contain an uninterruptible hardware real time clock accurate to ten (10) minutes per year. The clock shall contain the time of day, day, month, year, and day of the week. The system shall automatically correct for daylight savings time and leap years.
9. The BC shall contain self-diagnostics that continuously monitor the proper operation of the unit. A malfunction of the unit will be reported, and will inform the operator of the nature of the malfunction, and the control unit affected. It shall be possible to annunciate malfunctions as well as other control unit alarms at a selected central operator's terminal.
10. Building Controllers shall be sized to meet the requirements of the number of distributed and networked Custom Application Controllers, Application Specific Controllers, and Third Party Devices. Those requirements shall include, but not be limited to, the number of devices, the complexity of control sequences, the number of global points, the number of trends (and size of trends considering number of samples required), the number alarms, and the physical distances between subordinate networked nodes.

2.6 CUSTOM APPLICATION CONTROLLERS

A. General

1. Each Custom Application Controller (CAC) shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each unit shall be a microprocessor-based, multi-tasking, real-time digital control processor. Custom Application Controllers shall be fully programmable controllers capable of supporting and executing user defined programs in addition to firmware based routines. Programming in the modules shall function independently of the Building Controller and shall not depend on a functional communications network for execution. Loss of communications with other Custom Application Controllers, or Building Controller, shall result in the programming either continuing to execute in its most recent state or returning to some user defined default routine based on the detection of the communications failure by the Custom Application Controllers firmware or software. The ability to detect and respond to a communications failure will be required.

2. Custom Application Controllers shall be native Tier 3 communication devices.
 3. Custom Application Controllers shall be applied to Air Handling Units as well as system level control (Chilled Water System, Condenser Water System, Hot Water System, for example).
 4. Each controller shall support its own real-time operating system. Provide a time clock with battery backup to allow for stand-alone operation in the event communication with its Building Controller is lost and to ensure protection during power outages.
 5. Provide each unit with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM or a minimum of 72-hour battery backup shall be provided. All programs shall be field-customized to meet the user's exact control strategy requirements. Controllers utilizing pre-packaged or canned programs are not acceptable.
 6. Local alarming and trending capabilities shall be provided for convenient troubleshooting and system diagnostics. Alarm limits and trend data information shall be user-definable for any point.
 7. Each controller shall have connection provisions for a portable laptop PC. It shall allow the user to display, generate or modify all point databases and operating programs.
 8. The unit shall be capable of direct interface to a variety of industry standard sensors and input devices. It shall be possible for each unit to monitor the following types of inputs:
 - a. Analog inputs: 4 20 mA, 0 10 VDC, Thermistors, RTDs.
 - b. Digital inputs: Dry contact closure, Pulse accumulator.
 9. The unit shall directly control electronic actuators and control devices. Each unit shall be capable of providing the following control outputs:
 - a. Analog outputs: 4 20 mA, 0 10 VDC.
 - b. Digital outputs: Dry contact closure (pilot duty).
 10. Each CAC within the building control system shall perform control functions as defined by the operator. All control functions shall be executed within the CAC unit. Loop control shall be executed via direct digital control algorithms.
- B. It shall be possible to fully create, modify or remove control algorithms within a specific CAC unit while it is operating and performing other control functions. Changes shall be made either through a direct connection of the CAC and a laptop PC or via the network with a laptop PC connected to another controller or via the network from the Operator Workstation.

2.7 APPLICATION SPECIFIC CONTROLLERS

- A. Each Application Specific Controller (ASC) shall operate as a standalone controller capable of performing its control responsibilities independent of controllers in the network. Each unit shall be microprocessor based, digital control processor.
- B. Application Specific Controllers shall be applied to unitary equipment like Packaged Rooftop Air Handling Units (if controls not provided with RTU), Fan Coil Units, Unitary Ventilation Units, Variable Air Volume Terminal Units, etc.
- C. Application Specific Controllers shall be native Tier 3 communication devices.
- D. Each ASC shall either have a battery backed-up real time clock or shall receive a synchronized time and occupied/unoccupied status from a supervisory controller. Upon restoration after a loss

of power, the ASC shall revert to its previous state prior to loss of power, or scheduled status based upon the value of the real time clock.

- E. All programs and user-defined configurations shall be stored in non-volatile EEPROM or have a minimum of 72-hour battery backup.
- F. Each terminal unit shall be individually controlled using an ASC controller. ASC controllers shall communicate with the Building Controller via Tier 3 communication to implement global control strategies including occupied/unoccupied, space setup/setback, warm-up/cooldown. Each ASC controller or the thermostat shall have access to allow local configuration at the terminal unit. ASC controller shall be mounted in the terminal unit control cabinet or as shown on the drawings.
 - 1. ASC for use with VAV or fan powered terminals (FTU) shall have a differential pressure transducer based flow sensor. Standard control routines shall include pressure independent VAV, constant volume, parallel FTU, series FTU, and dual duct as required by the sequences of operation. The control routines shall include: shutdown mode, power fail restart mode, occupied/unoccupied mode, temporary occupied mode, warm-up mode, setpoint calculation, temperature control loops, damper control, fan control, exhaust box control, baseboard heat, box heat, lighting control, and auto zero.
 - 2. ASC for use with fan coil units, heat pumps, unit ventilators, small packaged rooftop, or generic point multiplexer shall include the following control routines: shutdown mode, power fail restart mode, occupied/unoccupied mode, temporary occupied mode, warm-up mode plus those required by the sequence of operations for the type of equipment being controller.
 - 3. Where ASC controllers are to be installed on terminal units, such as VAV boxes, reheater boxes, fan coil units, etc., the units may be field or factory installed or field installed. Regardless of whether the units are factory or field installed, all responsibilities and costs associated with coordinating this installation shall be carried by and under this section of the specification. This includes, but is not limited to, actuator coordination, velocity sensor coordination, relays, auxiliary contacts, enclosure requirements, power requirements, failure mode, normal position upon loss of power and signal, etc.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- B. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification [and on face of ceiling directly below instruments concealed above ceilings]. Comply with requirements for identification specified in Section 20 10 70 "Identification for Mechanical Systems."
- C. All devices relating to the work or systems included herein, including controllers, valves, motors, relays, auxiliary panels, etc., shall be identified with a unique identification number or name on the submitted engineering drawings. This identification number or name, along with the service of the device (discharge air controller, mixed air controller, etc.), shall be permanently affixed adjacent to the respective device. Identification shall be vinyl labels printed with thermal transfer printers, ½" high labels minimum.
- D. Terminal strips shall be labeled using plastic labels designed to snap into the label mounting slots on the terminals. For input/output wiring, cabling, or tubing, the panel side of the terminals shall be labeled with the automation panel circuit board and terminal numbers associated with the point.
- E. All wiring, tubing, and cabling both inside and outside of control panels shall be labeled at both ends using Thomas and Betts EDP printable wire and cable markers using style WSL self laminating vinyl. Input and output cables and wiring shall be labeled with the point number and the point description.
- F. Cable and wiring not specifically associated with an input or output shall be labeled with a number and a function description.

3.3 CONTROL DEVICES FOR EQUIPMENT MANUFACTURER FACTORY INSTALLATION

- A. Deliver control devices to unit manufacturer for factory installation. Include installation instructions to unit manufacturer.

3.4 INSTALLATION

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- C. Graphical User Interface
 - 1. The Graphical User Interface (GUI) computer shall be a network computer provided and maintained by the Owner on their Local Area Network. Interface to the BAS GUI shall be

through a web browser installed on that computer (Safari, Microsoft Edge, or Chrome), native and compatible with the Operating System installed on that computer.

2. Basic Interface Description

- a. GUI shall be English language prompting, English language point identification, on-line help, and industry standard PC application software. The software shall provide, as a minimum, the following functionality:
 - 1) Real-time graphical viewing and control of environment.
 - 2) Scheduling and override of building operations.
 - 3) Collection and analysis of historical data.
 - 4) Definition and construction of dynamic color graphic displays.
 - 5) Editing, programming, storage and downloading of controller databases.
 - 6) Alarm reporting, routing, messaging, and acknowledgment.
 - 7) Display of dynamic trend data plot.
- b. Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via user-sized windows:
 - 1) Dynamic color graphics and graphic control.
 - 2) Alarm management, routing to designated locations, and customized messages.
 - 3) Week at a Glance Time-of-day scheduling.
 - 4) Trend data definition and presentation.
 - 5) Graphic definition and construction.
 - 6) Program and point database editing on-line.
- c. Operator specific password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. Operator privileges shall "follow" the operator to any workstation that they log onto.
- d. Operator Activity Tracking - An audit trail report to track system changes, accounting for operator initiated actions, changes made by a particular person or changes made to a specific piece of equipment over a designated time frame shall be printable and archived for future use. The operator activity tracking shall be in a tamperproof buffer file.
- e. Reports shall be generated on demand or via pre-defined schedule and directed to either displays, printers, email recipient, or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:
 - 1) A general listing of all or selected points in the network.
 - 2) List of all points currently in alarm.
 - 3) List of all points currently in override status.
 - 4) List of all disabled points.
 - 5) List of user accounts and access levels.
 - 6) List all weekly schedules.
 - 7) List of holiday programming.
 - 8) System diagnostic reports including a list of DDC panels on line and communicating and status of all DDC terminal unit device points.
 - 9) List of programs.
- f. Scheduling and override shall be accomplished via a graphical format for simplification of time-of-day scheduling and overrides of building operations.
- g. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may

be trended automatically at time-based intervals or change of value, both of which shall be user-definable. Archival trend data may be stored at the Enterprise Server for future diagnostics and reporting. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.

- 1) Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of at least six points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily exported in CSV format.
3. Dynamic Color Graphic Displays
 - a. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands.
 - b. Dynamic values, with the specified units and precision, for temperature, humidity, flow, position, and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention and without predefined screen refresh rates.
 - c. Provide the user the ability to display blocks of point data by defined point groups.
 - d. Alarm conditions shall be identified graphically unique from other monitor points, with the use of flashing, text color, text background color, or other indication native to the DDC software platform.
 - e. Equipment state can be changed by clicking on the point block or graphic symbol and selecting the new state (on/off) or setpoint.
 - f. Colors shall be used to indicate status and change as the status of the equipment changes.
 - g. A dynamic display of the site specific control architecture showing the status of all controllers, operator workstations, and networks shall be provided.
4. System Configuration & Definition
 - a. Network wide control strategies shall not be restricted to a single DDC Controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.
 - b. Provide automatic backup and restore of all DDC controller databases on the Enterprise Server. In addition, all database changes shall be performed while the workstation is online without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller. Changes made at the DDC Controllers shall be automatically uploaded to the workstation, ensuring system continuity.
 - c. System configuration, programming, editing, graphics generation shall be performed online.
5. Alarm Management
 - a. Alarm Routing shall allow the user to send alarm notification to network printers or email recipients based on time of day, alarm severity, or point type.
 - b. Alarm Notification shall be provided priority levels, to distinguish between routine, maintenance type alarms and critical alarms.
 - 1) There shall be 4 levels of alarm
 - a) Level 1: Life-safety message
 - b) Level 2: Critical equipment message
 - c) Level 3: Urgent message

- d) Level 4: Normal message
- c. Alarm Display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message.
- d. Alarm messages shall be customized to each point to display detailed instructions to the user regarding actions to take in the event of an alarm.
- e. Maintenance Mode: Operators shall have the ability to put any device (e.g., AHU) in/out of maintenance mode.
 - 1) All alarms associated with a device in maintenance mode will be suppressed. Exception: Life safety alarms shall not be suppressed.
 - 2) If a device is in maintenance mode, issue a daily Level 3 alarm at a scheduled time indicating that the device is still in maintenance mode.
- f. Entry Delays: All alarms shall have an adjustable delay time such that the alarm is not triggered unless the alarm condition is TRUE for the delay time. Default entry delays are as follows:
 - 1) Level 1 alarms: 1 seconds
 - 2) Level 2 alarms: 10 seconds
 - 3) Level 3 alarms: 1 minutes
 - 4) Level 4 alarms: 5 minutes
- g. Exit Hysteresis: Each alarm shall have an adjustable time-based hysteresis (default: 5 seconds) to exit the alarm. Once set, the alarm does not return to normal until the alarm conditions have ceased for the duration of the hysteresis.
 - 1) Each analog alarm shall have an adjustable percent-of-limit-based hysteresis (default: 0% of the alarm threshold, i.e., no hysteresis; alarm exits at the same value as the alarm threshold) the alarmed variable required to exit the alarm. Alarm conditions have ceased when the alarmed variable is below the triggering threshold by the amount of the hysteresis.
- h. Latching: Any alarm can be configured as latching or non-latching. A latching alarm requires acknowledgement from the operators before it can return to normal, even if the exit deadband has been met. A non-latching alarm does not require acknowledgment. Default latching status is as follows:
 - 1) Level 1 alarms: latching
 - 2) Level 2 alarms: latching
 - 3) Level 3 alarms: non-latching
 - 4) Level 4 alarms: non-latching
- i. Post-exit Suppression Period: To limit alarms, any alarm may have an adjustable suppression period such that, if the alarm is triggered, its post-suppression timer is triggered and the alarm may not trigger again until the post-suppression timer has expired. Default suppression periods are as follows:
 - 1) Level 1 alarms: 0 minutes
 - 2) Level 2 alarms: 5 minutes
 - 3) Level 3 alarms: 24 hours
 - 4) Level 4 alarms: 7 days
- j. For both latching and non-latching alarms, the operators may acknowledge the alarm. Acknowledging an alarm clears the alarm, the exit deadband, and suppression period. A device can go right back into alarm as soon as the entry delay elapses.

6. Workstation Communications - Provide remote access for buildings as required by the contract documents. Automatic dial-out communications shall include the following features as a minimum:
 - a. Critical alarms shall automatically dial out for email recipients to be defined in the software database.
 - b. Alarms shall automatically display at the Graphical User Interface.
7. Application Notes for Specific Graphic Displays
 - a. System schematics for each piece of mechanical equipment, including air handling units, chilled water systems, hot water boiler systems, and zone controls shall be provided to optimize system performance analysis and speed alarm recognition. System arrangement on the graphical displays shall match the installed equipment configuration exactly, with respect to order and arrangement of components.
 - b. Each graphic shall contain the date, time, outdoor air temperature and humidity.
 - c. Floor plan graphics shall display zone temperatures. A graphic component indicating the actual location of the zone temperature sensor shall be included for each terminal unit or unitary equipment. Where a single VAV box is controlling multiple spaces, it should clearly identify all zones served by that VAV box.
 - d. System summary screens in a tabular format shall be provided for each system for overall system operation evaluation by the operators. These screens do not have graphical representation of the equipment, but are dynamically populated spreadsheet-type presentations of operational data of the supplied systems.
 - 1) Each individual air handling unit shall have a summary of the terminal units it serves, with one terminal unit on each row of the table. The table columns shall be: the terminal unit tag, zone temperature setpoint, zone temperature, airflow setpoint, airflow, damper command/position, heating command, discharge air temperature.
 - 2) An air system summary shall be provided, with one air handling unit on each row of the table. The table columns shall be: equipment tag, discharge temperature setpoint, discharge temperature, static pressures, fan status, fan speed command, cooling command, heating command, damper commands.
 - e. Cooling Plant Graphics: Graphics showing cooling towers shall include outdoor air wet bulb temperature. When applicable, cooling plant graphics shall show number of pressure reset requests.
 - f. Air Handling System Graphics: When applicable, system graphics shall show number of incoming heating and cooling requests, pressure reset requests, total VAV flow, total VAV flow setpoint, Max VAV damper position, and Min VAV damper position.
 - g. VAV Graphics: All VAV graphics shall include room name and number, and a link to the RTU which serves the VAV.
- D. Implementation/Development of Sequences of Operation
 1. Software sequences shall be provided as described on the drawings and/or as specified herein and as required to initialize and load the field point data base.
 2. These sequences are intended to be performance based. Implementations that provide the same functional result using different underlying detailed logic will be acceptable.
 3. Software testing requirements shall include testing in the field of all logic sequences including actual simulation of different processes and events and observing program

- response to the process or event. All deviations from the requirements of the sequence as specified shall be corrected immediately at no additional cost to the Owner.
4. Where several analog outputs are to be controlled in sequence by one control loop, software shall be arranged so that the sequence is guaranteed regardless of the spring range of the actuators and to prevent simultaneous heating and cooling.
 5. Programs controlling several pieces of equipment as one system shall reside in one field panel. Where programs use data points that reside in other panels the programs shall employ logic (either in software, firmware, hardware, or a combination of all three) to detect loss of communications with the remote panels containing the required data. When such a failure is detected, the program logic shall revert to a safe operating mode that will allow the controlled systems to remain in operation until normal system communication resumes.
 6. Network dependent processes should be avoided. For control processes, particularly control loops, all input sensor readings, output device operations, and logic control algorithms shall reside in a single field controller. For particularly difficult applications, or for less critical applications, network dependent processes should be presented specifically to the Engineer during the Shop Drawing submittal for review and acceptance.
 7. Unless otherwise indicated, control loops shall be enabled and disabled based on the status of the system being controlled to prevent windup.
 8. When a control loop is enabled or reenabled, it and all its constituents (such as the proportional and integral terms) shall be set initially to a neutral value.
 9. A control loop in neutral shall correspond to a condition that applies the minimum control effect, i.e., valves/dampers closed, VFDs at minimum speed, etc.
 10. Outside air conditions
 - a. When there are multiple outdoor air temperature sensors, the system shall use the valid sensor that most accurately represents the outdoor air conditions at the equipment being controlled.
 - b. Outdoor air temperature sensors at air-handler outdoor air intakes shall be considered valid only when the supply fan is proven ON and the unit is in occupied mode or in any other mode with the economizer enabled.
 - c. The outdoor air temperature used for optimum start, plant lockout, and other global sequences shall be the average of all valid sensor readings. If there are four or more valid outdoor air temperature sensors, discard the highest and lowest temperature readings.
 11. Use proportional only (P-only) loops for limiting loops (such as zone CO2 control loops, etc.). Do not use the derivative term on any loops unless field tuning is not possible without it.
 12. To avoid abrupt changes in equipment operation, the output of every control loop shall be capable of being limited by a user adjustable maximum rate of change, with a default of 25% per minute.
 13. All set points, timers, deadbands, PID gains, etc. listed in sequences shall be adjustable by the user with appropriate access level whether indicated as adjustable in sequences or not. Software points shall be used for these variables. Fixed scalar numbers shall not be embedded in programs except for physical constants and conversion factors.
 14. Values for all points, including real (hardware) points used in control sequences shall be capable of being overridden by the user with appropriate access level (e.g., for testing and commissioning). If hardware design prevents this for hardware points, they shall be

- equated to a software point, and the software point shall be used in all sequences. Exceptions shall be made for machine or life safety.
15. Every sensor input data point shall incorporate input value filtering, a time averaged value is preferable to change of value (COV) techniques. Due to the great variety in filtering requirements based on sensed value stability and process variable use, a prescriptive specification will not be provided in this guideline requirement. Rather, this requirement is to ensure that filtering is present in some form so that it may be adjusted during system tuning and acceptance, if so required, at no additional programming or cost.
 16. VFD Speed Points
 - a. The speed AO sent to VFDs shall be configured such that 0% speed corresponds to 0 Hz, and 100% speed corresponds to maximum speed configured in the VFD.
 - b. Minimum and maximum speeds shall be configured in the VFDs such that the controlled device cannot operate outside of its design range when operating in Auto or Hand.
 - c. The controller shall not send an AO signal which is below the minimum allowed % speed of the device.
 17. Provide all required standard data base development, input, and debugging as required by the project and point list including but not limited to point names, point groupings, point ranging, point alarm limits, backup file creation, message development, graphics development, etc.
 - a. Equipment controller naming, hardware naming, software naming, etc. shall all be named to match the unique equipment tag listed on the equipment schedules.
 - 1) For terminal devices and unitary equipment, the area of service description shall be the actual room number(s) on the building signage plus the space description agreed upon with the Owner.
 - b. Effort has been made to identify equipment on the equipment schedules in a manner consistent with the Owner's naming conventions. In the course of execution of this work, if equipment tags are found to be inconsistent with known standards, this contractor will bring these inconsistencies to the attention of the engineer for adjustments required.
 18. The point lists indicated on the points list and sequences of operation are minimum requirements for the job. The contractor shall provide all input and output points required by his system to perform the indicated sequence of operation, regardless of whether or not they are specifically listed in the points list or sequence of operation.
 - a. All set points shall be developed as software points stored at memory locations so that set points can be changed by recommending the data stored at the memory location rather than by entering the program and changing parameters and lines in programs.
- E. Database Semantic Tagging
1. The purpose of a data modeling standard is to provide a consistent, standardized methodology for naming and describing data points associated with facility automation systems, equipment systems, energy metering systems, other smart devices including mobile assets, and associated descriptive information known as metadata.
 2. This project will implement the Project Haystack database semantic tagging model.
 3. Technical Overview

- a. The Project Haystack data modeling standard for Buildings and Equipment systems uses a simple metamodel based on the broadly accepted concept of “tags” as described below. Tags are not point names in the Temperature Control System. They are independent entities that do not specifically describe the point or equipment in an of itself, but entities that specifically describe the point or equipment when they are queried as a group.
- b. Tags are name/value pairs, associated with entities like AHUs, electric meters, etc. Tags support the definition of the following essential data elements:
 - 1) Entity: An Entity is an abstraction for a physical object in the real world. Entities include sites, facilities, equipment, sensor points, weather stations, etc.
 - 2) Id: The id tag is used to model the unique identifier of an entity in a system using a Ref value type. Ref value types are determined by individual application. This identifier may be used by other entities to cross-reference entities, associations, and systems.
 - 3) Dis: The dis tag is used with entities to define display text used to describe an entity. Dis values are intended to be short (less than 30 or 40 characters), but fully descriptive of the entity for a human user.
- c. The model provides the following permitted tag value types:
 - 1) Marker: this tag type is merely a marker annotation with no meaningful value. Marker tags are used to indicate a "type" or "is-a" relationship.
 - 2) Bool: boolean "true" or "false".
 - 3) Number: integer or floating point number annotated with a Unit of Measurement, where ideally, units of measure are prescribed for various tasks.
 - 4) Str: a string of Unicode characters.
 - 5) Uri: a Universal Resource Identifier.
 - 6) Ref: reference to another entity. The Project Haystack specification does not currently prescribe specific identities or reference mechanisms, but should be used to cross link entities. Refs are formatted with a leading "@" and require a specific subset of ASCII characters be used: a-z, A-Z, 0-9, underbar, colon, dash, or dot.
 - 7) Bin: a binary blob with a MIME type formatted as Bin(text/plain)
 - 8) Date: an ISO 8601 date as year, month, day: 2011-06-07.
 - 9) Time: an ISO 8601 time as hour, minute, seconds: 09:51:27.354.
 - 10) DateTime: an ISO 8601 timestamp followed by timezone name: 2011-06-07T09:51:27-04:00 Chicago, 2012-09-29T14:56:18.277Z UTC
4. The Project Haystack data modeling standard provides a comprehensive library of standard tags to address common equipment, building systems, and devices types. Tags shall be developed and implemented in accordance with this standard library.

5. Application

- a. The goal of the Project Haystack data modeling standard is to ensure consistent modeling of building systems, devices and associated data. The following application requirements outline the use of the modeling standard in applications related to buildings, energy, and facility management.
- b. The Haystack Project implementation shall utilize defined data modeling tags to create an expanding, and coherent model with the following minimum items, hierarchy and relationships when used in facilities-oriented applications:
 - 1) Sites: Including display name, description, size (area) as a minimum. References to Internet-available weather stations are highly recommended, as are creating tags to represent other relevant characteristics of a Site such as year constructed, facility usage type, occupancy class, schedule(s) of operation, building systems type (e.g., packaged or central HVAC).
 - 2) Equipment: Including standardized associations with sites via id reference and display name as a minimum. Equipment and software vendors, model numbers, year of installation, and similar descriptive meta data are also recommended.
 - 3) Points: Including standardized associations with sites and equipment via id reference, units of measure as a minimum. Where possible, ranges of acceptable values are recommended.
- c. Exposing the Project Haystack Model via REST API: Software and web service applications, including control system devices will expose the model definitions described above using the Project Haystack REST API published as part of the Project Haystack standard, openly accessible and kept up to date at <http://project-haystack.org/doc/Rest>.
- d. Open Source Modules for Commercially Available Products.
 - 1) The Project Haystack Community has developed, and makes available, a comprehensive implementation of the Haystack protocol in the form of a software module for use with NiagaraAX-based systems. The module, known as NHaystack, is licensed under the Academic Free License ("AFL") v. 3.0. Public access to the NHaystack software module shall be maintained via the project-haystack.org site.
 - 2) When Niagara 4-based systems are used, the arcbeam.jar module shall be the installed in the Enterprise Server and each Station to provide communication between the Niagara 4-based devices and SkySpark systems that are interacting with Niagara data or writing commands to Niagara 4-based systems.

F. Calibration Requirements

1. Calibration shall be checked at a minimum of one point on the span of the device for temperature, pressure, and humidity sensors.
2. Specified accuracy shall be achieved at the field termination points of the device and shall include both sensor errors and transmitter errors.

3. For flow meters provide a factory calibration certificate where manufacturing tolerance are verified to prove geometric similarity to the original design standard upon which the product accuracy statements are based. NIST certificates are not required unless specifically noted in the flow meter specification.

G. System Performance Standards

1. System shall conform to the following minimum standards over network connections:
 - a. Graphic Display: A graphic with 20 dynamic points shall display with current data within 10 s.
 - b. Graphic Refresh: A graphic with 20 dynamic points shall update with current data within 8 s.
 - c. Object Command: Devices shall react to command of a binary object within 2 s. Devices shall begin reacting to a command of an analog object within 2 s.
 - d. Object Scan: Data used or displayed at a controller or workstation shall have been current within the previous 6 s.
 - e. Alarm Response Time: An object that goes into alarm shall be annunciated at the workstation within 45 s. Note that this is not a statement of alarm state evaluation, only of announcement of the alarm condition.
 - f. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 s. Select execution times consistent with the mechanical process under control.
 - g. Performance: Programmable controllers shall be able to completely execute BAS PID control loops at a frequency adjustable down to once per second. Select execution times consistent with the mechanical process under control.

H. Auxiliary Panels Installation and Fabrication

1. Auxiliary panels shall be fabricated to match the approved shop drawings submitted by the control contractor. Fabrication shall be in a neat and workmanlike manner and shall facilitate repair, maintenance, and adjustment of the equipment contained therein.
2. All equipment that is not providing an input from a field sensed process (static pressure, temperature, proof of flow, etc.) shall be installed in an auxiliary panel located as indicated on the drawings or as directed by the engineer.
3. Auxiliary panels shall be fabricated and laid out to incorporate the following features:
 - a. Identification of all internally and cover mounted devices. Cover mounted labels shall be engraved labels or shall be vinyl labels printed with thermal transfer printers, 1" high labels minimum. Labels for internal devices may be shall be vinyl labels printed with thermal transfer printers, 1/2" high labels minimum. Labels shall be mounted adjacent to the device they are associated with so that replacement of the device does not eliminate the label.
 - b. All input and output wiring entering the stand alone control units shall be terminated on terminal strips. If such terminal strips are not furnished as a standard part of the stand-alone control unit termination points, then they shall be installed in an auxiliary panel located immediately adjacent to the stand-alone unit.
 - c. All internal wiring shall be run inside plastic wiring duct as manufactured by Tyton. Wire duct shall be sized to hold the required number of wires without crimping the wires and with sufficient space to allow wiring to be traced during troubleshooting operation.

- d. Wires that pass from the panel interior to cover mounted devices shall be provided with a flex loop that is anchored on both sides of the hinge.
- e. All control panels shall be provided with removable sub-panels to allow the panel enclosures to be installed at the job site during rough in while the panels are fabricated off site for later installation.
- f. Provide strain relief type cord and cable connectors for all cables that leave the panel as individual cables not in conduit.
- g. Provide one duplex outlet mounted inside the control panel and separately fused with a non time delay fuse at 15 A at any panel location containing electronic or electrical control components. This receptacle may be served from the control panel's 120 VAC power source.
- h. Each panel shall be provided with a control power disconnect switch located and wired so as to disconnect all control power in the panel. The leaving side of this switch shall be wired to the panel and field components through a fuse or fuses sized and applied to protect both the components of the system as well as the wire and as required for code compliance.
- i. Enclosures shall be NEMA 1 for indoor dry locations and NEMA 4/12 for indoor wet and outdoor locations. Enclosures shall be fabricated from a minimum of 16 gauge steel with continuously welded and ground smooth seems. Doors shall have hinges to open 180°, oil resistant gasket, a removable print pocket, quarter turn latch mechanism with key lock handle and lock cylinder. Grounding studs shall be welded to both the body and the door. Collar studs shall be provided to mount a subpanel. Finish shall be gray ANSI 61 polyester powder inside and out over phosphatized surfaces.
- j. All wiring leaving the panel shall be separated by classification; i.e., Class 1 circuits shall not be run with Class 2 circuits, etc. Segregation shall be maintained inside the panel to the fullest extent possible. Where low voltage wires carrying low level AC and DC signals cross wires containing power and high level ac signals, the wires shall cross at a 90° angle.
- k. Panels shall be shop fabricated and tested prior to installation in the field. The Owner's representative shall be given the opportunity to witness the testing of the panels. The panels may be inspected and approved by the Owner's representative at the assembly location prior to installation in the field.
- l. Panels with controls for equipment and systems that operate on generator power shall have a local UPS power supply integral to the primary power circuit of the panel to retain controller power throughout the Automatic Transfer Switch switching period, minimum of 10 s.

3.5 TRAINING

- A. The contractor shall provide a representative from the company used as the source for the electronic controllers used in the systems installed under this contract. The representative shall conduct the training class on the project site at a time scheduled in advance with the Owner and shall occur during or immediately following system start up. These instructions are to be conducted during normal working hours. All pertinent costs shall be included in this contract.

END OF SECTION 25 10 00

SECTION 25 20 00 – AIR SIDE CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Air temperature sensors
 - 2. Differential pressure sensors
 - 3. Automatic control dampers and actuators
 - 4. Airflow measurement
- B. Related Requirements:
 - 1. Section 25 00 00 TEMPERATURE CONTROL SYSTEM

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 OUTDOOR AIR TEMPERATURE SENSOR

- A. Sensor shall be tip sensitive 10,000 ohm Thermistor or 1,000 ohm RTD.
 - 1. Thermistor element shall be 10,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, $\pm 1\%$ at 25°C or $\pm 0.36^\circ\text{F}$ accuracy.

2. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, $\pm 1\%$ at 25°C or $\pm 0.36^{\circ}\text{F}$ accuracy.

- B. The housing shall be a NEMA 4 aluminum box with gasket cover or ABS enclosure that will accept water tight conduit connections. The sensor shall be integrally shielded from sunlight and weather with good ventilation for accurate readings, do not rely on building structure to provide shade. If sensor is not provided with integral sun shield, provide optional accessory to accommodate.
- C. Precon model ST-O, ACI model A/xx-O-BB(EH), BAPI model BA/10K(1K)-O-BB2, or approved equivalent.

2.3 DUCT TEMPERATURE SENSOR – FOR AIR HANDLING UNIT SYSTEMS

- A. Sensor shall be tip sensitive 10,000 ohm Thermistor or 1,000 ohm RTD.
 1. Thermistor element shall be 10,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, $\pm 1\%$ at 25°C or $\pm 0.36^{\circ}\text{F}$ accuracy.
 2. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, $\pm 1\%$ at 25°C or $\pm 0.36^{\circ}\text{F}$ accuracy.
- B. The housing shall be a 4" x 2" galvanized steel utility box with cover or ABS enclosure that will accept conduit connections. The bottom of the housing shall have a foam gasket to seal the housing to the duct to minimize air leakage.
- C. Minco model S451PFY, Precon model ST-Dx-XH(P), ACI model A/10K(1K)-D-8-GD(BB), BAPI model BA/10K(1K)-D-8"-JB, or approved equivalent.

2.4 DUCT TEMPERATURE SENSOR – FOR TERMINAL UNIT EQUIPMENT

- A. Sensor shall be tip sensitive 10,000 ohm Thermistor or 1,000 ohm RTD.
 1. Thermistor element shall be 10,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, $\pm 1\%$ at 25°C or $\pm 0.36^{\circ}\text{F}$ accuracy.
 2. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, $\pm 1\%$ at 25°C or $\pm 0.36^{\circ}\text{F}$ accuracy.
- B. The sensor shall be provided without enclosure, but with mounting tabs, grommet seal, and integral plenum rated cable of sufficient length (5' minimum) that sensor terminations are made directly at the terminal unit controller without any splices between sensor and controller.
- C. Precon model KTVx-XCP5, Mamac model TE-701-BX-x-A, BAPI model BA/10K(1K)-D-4"-NB-5', or approved equivalent.

2.5 DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS

- A. Sensor shall be bendable copper or aluminum sheath, continuous sensing 10,000 ohm Thermistor or 1,000 ohm RTD.
 1. The element shall be 10,000 ohm thermistor, with a reference temperature coefficient of resistance (TCR R25/125) compatible with the system installed, $\pm 0.36^{\circ}\text{F}$ accuracy.

2. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, $\pm 1\%$ at 25°C or $\pm 0.36^{\circ}\text{F}$ accuracy.
- B. The housing shall be 4" x 2" galvanized steel utility box with cover or ABS enclosure that will accept conduit connections. The bottom of the housing shall have a foam gasket to seal the housing to the duct to minimize air leakage.
- C. Sensor length shall provide coverage of 20' element per 25 square feet of installed area.
- D. Precon model ST-FZ, ACI Model A/xx-A-24-GD, BAPI model BA/10K-x-A24-JB, or approved equivalent.

2.6 LOW LIMIT THERMOSTAT (FREEZESTAT)

- A. Low limit thermostats shall be snap-acting contact thermostats with vapor-charged sensing element. Thermostat shall have normally closed SPST main contact and normally open SPST auxiliary contact. Main contact shall be rated 16 A inductive load at 120 VAC. Auxiliary contact shall be rated 16 A inductive load at 120 VAC.
- B. Thermostat shall have setpoint range of 15°F – 55°F .
- C. Thermostat shall have a 20-foot long remote bulb strung in free air downstream of the heating coil but upstream of the cooling coil. The control shall respond to the lowest temperature along any one foot section of sensing element.
- D. The coil shall have the manufacturer's recommended coverage, with 20' element per 25 square feet of installed area minimum. Provide multiple thermostats wired in series where the coil area exceeds the maximum coverage.
- E. Low limit thermostat reset.
 1. Manual reset low limit thermostats shall be operate by manual reset (no fixed differential).
 2. Automatic reset low limit thermostats shall operate on a fixed 5°F differential.
- F. Manual reset low limit thermostats shall be Johnson Controls A70HA-1C, Robertshaw T322, or approved equivalent.
- G. Automatic reset low limit thermostats shall be Johnson Controls A70GA-1 or approved equivalent.

2.7 ROOM TEMPERATURE SENSOR

- A. Room temperature sensors listed in this section shall be for auxiliary sensing applications only, as indicated on the Drawings, Sequences of Operation, or Points Lists. Room temperature sensors applied to terminal unit controllers are specified under Room Smart Sensors.
- B. Sensor shall be tip sensitive 10,000 ohm Thermistor or 1,000 ohm RTD.
 1. Thermistor element shall be 10,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, $\pm 1\%$ at 25°C or $\pm 0.36^{\circ}\text{F}$ accuracy.

2. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, $\pm 1\%$ at 25°C or $\pm 0.36^{\circ}\text{F}$ accuracy.

C. Sensor covers.

1. Sensor with plastic covers shall match the Room Smart Sensors on the project.
2. Flush sensors shall be box-mounted flush stainless steel wall plate.

2.8 ROOM SMART SENSOR

A. Room smart sensors shall be integral components of the DDC system ASC controller line. They should be the sensors that are generally applied for terminal unit zone controls. They are sensors that are generally available in a variety of configurations that have temperature sensing as a base function but include options for additional sensors and configurations for project-specific requirements.

1. Sensor chassis shall be configured to provide aspiration of all sensing elements for accurate indication of zone condition when installed on a wall surface.
2. Temperature Sensor: Temperature sensor shall be integral to the board assembly of the device, shall have a sensing range of 32°F - 104°F , with an accuracy of 0.35°F .
3. Temperature Indication: Local indication of temperature shall display the same value that is in use by the control routine resident in the associated ASC. Local displayed values that differ from the controlling program are not permitted. Temperature indication shall be whole number values only (no decimals displayed) or rounded to nearest 0.5°F if a single decimal place is enabled.
4. Insulated bases are required for all Room Smart Sensors installed on exterior walls or on furred-out columns.
5. Temperature Setpoint Adjustment: Temperature setpoint adjustment mechanisms are preferred to be provided with relative adjustment indication (higher/lower, blue/red, left/right) rather than absolute values printed on the device (specific temperatures).
6. Occupancy Override: A local push-button shall be provided on the Room Smart Sensor for manual initiation of temporary occupancy override.
7. Relative Humidity Sensor: Relative humidity sensor shall be integral to the board assembly of the device, shall have a sensing range of $20\%\text{RH}$ - $80\%\text{RH}$ (non-condensing), with an accuracy of $\pm 2\%\text{RH}$.
8. Carbon Dioxide Sensor: Carbon dioxide sensor shall be integral to the board assembly of the device, shall have a sensing range of 400 ppm - 1250 ppm , with an accuracy of $\pm 40\text{ ppm}$ and $\pm 3\%$.
9. All sensors shall have service jack for local configuration.
10. The sensor options included herein are common for sensors of this type. The values to be monitored are specific to this project. As the options available in a single sensor vary by manufacturer, if the required options for a specific zone are not available in a single device for the installed system, it is the responsibility of this contractor to provide the number of devices (and full installation including rough-in, wiring, devices, programming, and engineering) to comply with the requirements of the zone.

B. Sensor configuration will vary by zone requirements. Configuration types are listed below:

1. Type S1 shall have Temperature Sensor only.
2. Type T1 shall have Temperature Sensor and Temperature Setpoint Adjustment only.
3. Type T2 shall be similar to Type T1, with addition of Occupancy Override.

4. Type T3 shall be similar to Type T2, with addition of Temperature Indication.
5. Type TH1 shall have Temperature Sensor, Relative Humidity Sensor, and Temperature Setpoint Adjustment only.
6. Type TH2 shall be similar to Type TH1, with addition of Occupancy Override.
7. Type TH3 shall be similar to Type TH2, with addition of Temperature Indication.
8. Type TC1 shall have Temperature Sensor, Carbon Dioxide Sensor, and Temperature Setpoint Adjustment only.
9. Type TC2 shall be similar to Type TC1, with addition of Occupancy Override.
10. Type TC3 shall be similar to Type TC2, with addition of Temperature Indication.

2.9 GENERAL PURPOSE RELATIVE HUMIDITY SENSOR

- A. Due to the wide variation in Relative Humidity sensor performance and the importance of the information used based on their readings, the sensors listed herein as approved sensors have third party testing results verifying performance characteristics. A primary resource for this reference is the National Building Controls Information Program April 2004 Product Testing Report on Duct-Mounted Relative Humidity Transmitters. The intent of the listed products is not to limit manufacturers used, but to ensure similar demonstrated performance of allowed devices. Consideration for substitute sensors should include a similar published third party product report. Consideration for substitute sensors will be made based on Owner's current installed stock. Application consideration has been given to differentiate use of the sensors specified herein above and beyond the use of Room Smart Sensors specified elsewhere in this specification. Engineer has determined that the sensors indicated in this section are required for this specific application.
- B. General Purpose Duct Relative Humidity Sensor:
 1. Sensor shall employ bulk polymer resistance or capacitance technology, 3% RH accuracy, 4-20 mA or 0-5 VDC transmitter factory matched and calibrated and replaceable tip. Sensor may incorporate integral temperature sensor. Sensor shall be ACI A/RH3-D or approved equal.
- C. General Purpose Room Relative Humidity Sensor:
 1. Sensor shall employ bulk polymer resistance or capacitance technology, 3% RH accuracy, 4-20 mA or 0-5 VDC sensor transmitter factory matched and calibrated and replaceable tip.. Sensor may incorporate internal temperature sensor. Sensor shall be ACI A/RH3-R, JCI HT-6703-0N00W, Mamac HU-225-3 or approved equal.
- D. General Purpose Outside Relative Humidity Sensor:
 1. Sensor shall employ bulk polymer resistance or capacitance technology, 3% RH accuracy, 4-20 mA or 0-5 VDC transmitter factory matched and calibrated and replaceable tip. Sensor may incorporate integral temperature sensor. If not included in base model, provide sun shield. Sensor shall be ACI A/RH3-O or approved equal (including substitution provisions indicated above for this specific product).

2.10 GENERAL PURPOSE AIR DIFFERENTIAL PRESSURE TRANSMITTER

- A. Transmitter range shall be as indicated on the Points List. Transmitter shall be a fixed range device, multi-range devices are not acceptable.

- B. Transmitters shall be a two-wire device producing a 4-20 mA output. Accuracy shall be 1% full scale or better, including non-linearity and hysteresis.
- C. Transmitters that are panel mounted may be open frame design. Transmitters that are not installed in an auxiliary control panel shall be provided with an enclosure that accommodates a conduit connection.
- D. Transmitter shall be Setra model 264, Ashcroft model CXLdp, or Modus model T30.

2.11 DIFFERENTIAL PRESSURE TRANSMITTER SENSING PROBE

- A. For unit or duct mounted pressure sensing locations, provide static pressure probe with 1/4" brass barb or compression connection and gasketed mounting flange. Static pressure probe shall be Mamac model A-520, Dwyer model A-489/491/493, or approved equal.
- B. For space mounted pressure sensing locations, provide flush mounted white ABS static pressure probe with 1/4" barb connection, for mounting on single gang electrical box or ceiling tiles. Static pressure probe shall be Mamac model A-523, Dwyer model A-465, or approved equal.
- C. For outside air reference pressure sensing locations, provide plastic pressure probe with internal reservoir, sensing head baffle to negate wind effects, mounting bracket, and 50 feet of vinyl tubing. Device shall be Dwyer A-420A/A-306/A-306-A or approved equal.

2.12 CARBON DIOXIDE (CO2) SENSORS

- A. Due to the wide variation in Carbon Dioxide sensor performance and the importance of the information used based on their readings, the sensors listed herein as approved sensors have third party testing results verifying performance characteristics. A primary resource for this reference is the National Building Controls Information Program March 2010 Product Testing Report on Wall-Mounted Carbon Dioxide Transmitters. The intent of the listed products is not to limit manufacturers used, but to ensure similar demonstrated performance of allowed devices. Consideration for substitute sensors should include a similar published third party product report. Consideration for substitute sensors will be made based on Owner's current installed stock. Application consideration has been given to differentiate use of the sensors specified herein above and beyond the use of Room Smart Sensors specified elsewhere in this specification. Engineer has determined that the sensors indicated in this section are required for this specific application.
- B. Sensor shall employ beam absorption infrared sensing technology with detection range of 0 – 2,000 ppm and an accuracy of 3%. Sensor shall be in a white enclosure for mounting directly within room without readout display and appear similar to room temperature sensor. Output to be 4-20 mA transmitter factory matched and calibrated.
- C. Sensor shall be ACI Model A/CO2-VEN, Honeywell Vulcain Model SM90DM3A, or approved equal (including substitution provisions indicated above for this specific product).

2.13 AUTOMATIC CONTROL DAMPERS

- A. Control dampers shall be provided where indicated on the drawings or as required for proper system operation.
- B. Airfoil Control Dampers
 - 1. Dampers shall be constructed from minimum 12 gauge extruded aluminum blades and frames. Blades shall be locked to the blade shaft by a positive means other than setscrews. Such means include ribs extruded into the blade that fit slots in the damper shaft and hexagonal shafts that fit tightly in hexagonal holes extruded into the blades.
 - 2. Shafts shall be provided with bearings at all support locations.
 - 3. Dampers shall be equipped with blade and jamb seals and shall have a leakage rate less than 0.1% of maximum flow.
 - 4. Linkage shall be concealed in the jamb out of the air stream where such an arrangement will be accessible for maintenance and lubrication without removal of the unit from the duct system or fan system that it is installed in. In all other cases the linkage shall not be concealed in the frame.
 - 5. Dampers with vertically oriented blades shall be provided with thrust bearings to support the vertical blades.
 - 6. Airfoil dampers shall be provided where fan discharge dampers are required and/or where minimum pressure drop at full flow is necessary.
 - 7. Dampers shall be Ruskin Model CD-40, Greenheck Model VCD-43 or approved equal.
- C. General Purpose Control Dampers
 - 1. General purpose control dampers shall be constructed from minimum 16-gauge steel or minimum 12 gauge extruded aluminum blades and frames. Blades shall be locked to the blade shaft by a positive means other than setscrews. Such means include ribs extruded into the blade that fit slots in the damper shaft and hexagonal shafts that fit tightly in hexagonal holes extruded into the blades.
 - 2. Shafts shall be provided with bearings at all support locations.
 - 3. Dampers shall be equipped with blade and jamb seals and shall meet the leakage specifications indicated on the damper schedule.
 - 4. Linkage shall be concealed in the jamb out of the air stream where such an arrangement will be accessible for maintenance and lubrication without removal of the unit from the duct system or fan system that it is installed in. In all other cases the linkage shall not be concealed in the frame.
 - 5. Dampers with vertically oriented blades shall be provided with thrust bearings to support the vertical blades.
 - 6. Non Airfoil dampers shall be provided at locations where Airfoil dampers are not required. Dampers shall be sized to provide adequate pressure drop at full flow to insure adequate control without hunting.
 - 7. Dampers shall be Ruskin CD-36, Greenheck Model VCD-23 or approved equal.
- D. Control Damper Sizing and Application
 - 1. Modulating damper sizing shall be based on the following conditions:
 - a. Minimum velocity - 2000 fpm
 - b. Maximum velocity - 3000 fpm
 - c. Minimum pressure drop - 0.2" w.c.
 - d. Maximum pressure drop - 0.3" w.c.

- e. Coordinate with the installing trade contractor any required blank-off plates for dampers that are smaller than duct size.
- 2. Two position dampers shall be the full size of the duct they are associated with unless otherwise specified.
- 3. Flow rates for damper sizing shall be based upon the flow rates indicated on the equipment schedules.

2.14 DAMPER ACTUATORS

- A. Actuators shall be sized with enough torque to close damper against fan shut off pressure. Provide multiple dampers and actuators as required to obtain close off. In all cases torque shall be a minimum 7.5 in-lb/ft² for opposed blade dampers and 10.5 in-lb/ft² for parallel blade dampers.
- B. Actuators shall be direct coupled electric actuators with electronic overload or digital rotation sensing circuit to prevent damage to the actuator throughout the full range of movement. End switches to deactivate the actuator at the end of rotation or magnetic clutch are not acceptable.
- C. For power-failure/safety applications, a mechanical spring return mechanism shall be used. Non-mechanical forms such as battery back-up and capacitor discharge are not acceptable. The normal position is the position that the actuator must fail to upon loss of control signal or power.
- D. Proportional and triac actuators shall have an external gear release. Spring return proportional actuators shall have a manual crank to allow manual positioning when the actuator is not powered.
- E. Proportional actuators shall accept a 2 to 10 VDC or 4-20 mA input signal. Actuators shall operate on less than 10 VA.
- F. Actuators shall have a direction rotation switch to aid in installation and provide proper control response.
- G. Actuators shall be listed under UL873.
- H. Actuators shall have a 2-year warranty starting from the date of acceptance.
- I. Actuators shall be Belimo, Siemens, or approved equal.
- J. Unless noted elsewhere, the following shall apply for damper actuator application:
 - 1. Air handling unit control dampers shall be 2-10 VDC proportional, spring return actuators. Outdoor air and relief air shall be NC, return air shall be NO.
 - 2. VAV box damper actuators shall be Triac (tri-state).
 - 3. Smoke dampers shall be 2-position, spring return NC, and shall have 120 VAC actuators.
- K. Actuators installed on the exterior of the building shall be provided with a NEMA 4X protective housing accessory as manufactured by the actuator manufacturer, Belimo ZS-300 or approved equal. Field-assembled steel weather shields or polycarbonate weather shields are not acceptable.

2.15 THERMAL DISPERSION AIRFLOW MEASUREMENT

- A. Thermal dispersion airflow sensors shall be used in duct-mounted applications only, with air filters at some location upstream of the airflow sensor.
- B. Thermal dispersion airflow sensors shall have an assembly installed airflow accuracy of $\pm 3\%$ of reading for duct and plenum applications.
 - 1. Probes shall be rated for -20°F to 140°F , 0% RH to 100% RH (non-condensing) ambient conditions.
 - 2. Transmitters shall be rated for -20°F to 120°F , 5% RH to 90% RH (non-condensing) ambient conditions.
 - 3. Transmitter shall be provided with two field selectable, scalable and isolated analog output signals. One output shall be for airflow indication, the other output shall be selectable temperature or alarm.
 - 4. Airflow measurement probe shall have $\pm 2\%$ of reading accuracy and shall be calibrated to a range of 0 fpm – 5,000 fpm over 16 calibration points.
 - 5. Temperature measurement probe shall have $\pm 0.15^{\circ}\text{F}$ accuracy and shall be calibrated to a range of -20°F to 160°F over 3 calibration points.
- C. Flow meter shall be Ebtron Advantage 3 Gold Series, Ruskin Model TDP05K, Air Monitor ELECTRA-flo or approved equal.

2.16 FIXED ORIFICE DIFFERENTIAL PRESSURE AIRFLOW MEASUREMENT

- A. Differential pressure across a fixed orifice shall be utilized for outdoor intake airflow measurement applications.
- B. Differential pressure across fixed orifice airflow sensor probes shall be 316 Stainless Steel and shall be constructed so they are not affected by moisture, dirt, or debris.
 - 1. Fixed orifice shall be expanded steel in galvanized steel flanged casing.
 - 2. Flow transmitter shall be in a NEMA 1 enclosure, with integral graphic display and keypad for field configuration, stacked transducers for each channel, barometric pressure compensation, ambient temperature compensation, and four configurable outputs for the DDC system.
- C. Flow meter assembly shall be the appropriate mounting adaptation of the OAM II System from Air Monitor Corporation.

2.17 ENGINEERED OUTDOOR AIRFLOW MEASUREMENT SYSTEM

- A. Engineered outdoor air airflow measurement systems shall be utilized for outside airflow measurement at air handling units with mixing box configurations.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing conditions....

3.2 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

- A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.
- B. Deliver the products specified in this section and related accessories to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.

3.3 INSTALLATION

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- C. Outdoor Air Temperature Sensor
 - 1. Outdoor air sensor shall be located where shown on the drawings or in a place as directed by the Architect/Engineer. Location shall be accessible for annual routine maintenance of sensor for calibration or replacement.
- D. Duct Temperature Sensor – For Air Handling Unit Systems
 - 1. Sensor length shall be coordinated with ductwork; length shall be at least 6” beyond insulation or inner wall of duct.
- E. Duct Temperature Sensor – For Terminal Unit Equipment
 - 1. Sensor length shall be coordinated with ductwork; length shall be at least 4” beyond insulation or inner wall of duct.
 - 2. Sensor shall be installed on a vertical duct face, at the midpoint of the duct to avoid stratification and mixing effects from the reheat coil. Sensors shall not be installed on the top or bottom of the duct without explicit direction or approval of the Engineer. Sensor shall be installed before the first air outlet tap from the distribution ductwork, but as far downstream as allowable by the integrated plenum cable.
- F. Duct Temperature Bendable Averaging Elements
 - 1. Temperature sensing elements shall be strung in free air and shall not be supported from the face of the coil to prevent the temperature of the coil media from affecting the element reading.

2. Where element is bent to turn in air stream, provide a manufactured insulated capillary mounting clip at each turn point. Capillary mounting clip shall be Klipet CC-1G-K, M-648-K copper clad mounting clip (only if element insulated from metal-to-metal contact with polyethylene tubing around element within capillary clip), or approved equivalent.

G. Low Limit Thermostat (Freezestat)

1. All low limit thermostat circuits shall have a manual reset function to restore normal system operation following correction of freeze condition. The manual reset function may be achieved with manual reset low limit thermostats, or with automatic reset low limit thermostats and manual reset circuits as indicated below:
 - a. For installations where all low limit thermostats can be mounted on the exterior of the unit, or inside the unit on the same side as the access door, and within 8 feet of the finished floor, manual reset low limit thermostats may be used.
 - b. For installations where any low limit thermostat is mounted above 8 feet over the finished floor or on the interior of the unit on the opposite side of the access door, automatic reset low limit thermostats with manual reset circuits must be used.
 - c. Application of automatic reset low limit thermostats requires the pairing of a manual reset circuit. That manual reset circuit may be achieved with a latching relay and pushbutton reset, or with a packaged fan safety relay board with manual reset switch, at contractor's option. The reset button may be located at the unit in a remote enclosure, or inside the unit control enclosure, at contractor's option.
 - d. Low limit thermostat arrangements must meet the installation details indicated in the specifications that follow, and must meet the manufacturer's installation requirements.
2. Temperature sensing elements shall be strung in free air and shall not be supported from the face of the coil to prevent the temperature of the coil media from affecting the element reading. Where element is bent to turn in air stream, provide a manufactured insulated capillary mounting clip at each turn point. Capillary mounting clip shall be Klipet CC-1G-K, M-648-K copper clad mounting clip (only if element insulated from metal-to-metal contact with polyethylene tubing around element within capillary clip), or approved equivalent.
3. The thermostat shall only be installed in the vertical position, with the sensing bellows on the bottom of the thermostat. The thermostat shall be mounted above the capillary sensing tube and the sensing tube shall run horizontally, below the bellows.

H. Room Mounted Device Installation:

1. All devices shall be installed on boxes or mounting plates secured to the building structure, wall studs, etc., prior to the installation of the wall covering or finish.
2. Rough ins for low voltage electric and/or electronic devices shall consist of a box or plate with the required number of conductors or cables securely fastened to it and extended to a location out of the wall in which the thermostat is mounted for connection to the control system. Conduit shall be provided at locations where the conductors will be embedded in plaster, concrete, or masonry to protect the conductors and allow easy replacement if necessary.
3. Rough ins for line voltage devices shall be in conduit in all cases.
4. Mounting heights for temperature sensors, thermostats, or relative humidity located on walls in occupied spaces shall be adjacent to the light switch (for ADA accessibility) unless otherwise directed by the Architect/Engineer.

5. Mounting heights for CO₂ and other gasses with a density similar to air, or other sensors not requiring user adjustment, located on walls in occupied spaces shall be at 60" AFF, unless otherwise directed by the Architect/Engineer.
 6. Mounting heights of sensors for gasses lighter than air (methane, ammonia, etc.) shall be located near or on the ceiling, gasses heavier than air (refrigerants, propane, etc.) shall be located near the floor, review proposed locations with Engineer prior to installation.
 7. All room sensors installed on exterior walls shall include insulated backing, utilizing 0.25" closed cell foam pads as a minimum.
- I. Room Temperature Sensor
1. Temperature sensors installed in occupied spaces shall have plastic covers that match the Room Smart Sensors on the project.
 2. Temperature sensors installed in common areas (corridors) or secure areas shall be box mounted with flush stainless steel wall plate.
- J. Room Smart Sensor
1. Unless noted differently elsewhere, S1 shall be used in public spaces (i.e., corridors, restrooms, lounges, etc.), T2 shall be used in Offices, TC2 for Conference Rooms, T1 shall be used in all other spaces.
 2. Unless explicitly specified or approved by the Engineer, all Room Smart Sensors shall be wired devices connected to the terminal equipment they control, wireless sensors are not allowed without explicit instruction or approval prior to bid submittal.
- K. Relative Humidity Sensor
- L. General Purpose Air Differential Pressure Transmitter
1. If not designated otherwise on the Points List, sensor ranges shall be as follows:
 - a. AHU downstream (remote from unit) duct static pressure transmitters shall be unidirectional, 0-2.5"w.c. range.
 - b. AHU discharge (local to unit) duct static pressure transmitters shall be unidirectional, 0-5.0"w.c. range, or 1.2 times greater than fan pressure, whichever is greater.
 - c. Mixed air and relief air box pressure transmitters shall be bidirectional, ± 0.50 "w.c. range for air handling units without heat wheels.
 - d. Mixed air and relief air box pressure transmitters shall be bidirectional, ± 1.00 "w.c. range for air handling units with heat wheels.
 - e. Building pressure transmitters shall be bidirectional, ± 0.10 "w.c. range.
 - f. Space pressure transmitters shall be bidirectional, ± 0.10 "w.c. range.
 - g. Fan Piezo Ring pressure transmitters shall be unidirectional, range verified with the fan manufacturer's published requirements at design maximum airflow, typically 0-10"w.c. range.
 - h. Air filter pressure transmitters shall be unidirectional, 0-2.5"w.c. range.
- M. Differential Pressure Transmitter Sensing Probe
1. For space mounted pressure sensing locations, provide minimum of 25 feet of 1/4" polyethylene tubing between static pressure probe and pressure transmitter, coiled and wrapped neatly, to provide surge dampening for opening and closing of doors.
 2. For outside air reference pressure sensing tubing, do not trim vinyl tubing to length, leave at full length to provide surge dampening of sensed pressure.

3. Outside air reference tubing exceeding 75 feet in length shall be increased in size from 1/4" tubing to 3/8" OD, 0.020" wall hard copper tubing with solder fittings, and transitional fittings provided at each connected device.
 4. Pressure sensor reference tubing applications:
 - a. AHU downstream (remote from unit) duct static pressure transmitters shall reference the ceiling plenum or space if no ceiling is present.
 - b. AHU discharge (local to unit) duct static pressure transmitters shall reference the mechanical room.
 - c. Mixed air and relief air box pressure transmitters shall reference the outdoors (building exterior).
 - d. Building pressure transmitters shall reference the outdoors (building exterior).
 - e. Space pressure transmitters shall reference the adjacent space of isolation.
- N. Automatic Control Dampers and Damper Actuators
1. Install dampers and actuators to be accessible for visual inspection and service.
 2. 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.
 3. Install dampers straight and true, level in all planes, and square in all dimensions.
 4. Install supplementary structural reinforcement for large multiple-section dampers if factory-furnished support alone cannot handle loading.
 5. Attach field-installed actuator(s) to damper drive shaft.
 6. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.
- O. Airflow Measurement
1. Flow meters shall be as scheduled on the plans and specified here-in.
 2. The controls contractor shall provide flow meters and associated installation kits to the mechanical contractor for installation under other sections of the specification
 3. Sensing elements shall be adequately supported for the velocities and spans encountered in the duct system.
 4. Sensing element probe densities shall be sized according to manufacturer's recommendations according to installed duct size.
 - a. Enhanced probe densities are required for outside air flowmeters installed upstream of control dampers. Consult manufacturer's recommendations for density required.
 5. All necessary power requirements for the transmitter shall be provided under this section of the specification.
 6. Temperature control contractor shall review with the mechanical contractor the required upstream and down stream requirements for the meter technology. In general unless the meter alters the flow profile as part of its technology then the following minimum general rules shall be followed for installation of sensing probes:
 - a. Turning Vanes: 3 diameters downstream, 3 diameters upstream.
 - b. Radius Elbows: 4 diameters downstream, 3 diameters upstream.
 - c. Tees: 5 diameters downstream, 2 diameters upstream.
 - d. Reducers: 2 diameters downstream, 2 diameters upstream.
 - e. Expansions: 5 diameters downstream, 1 diameter upstream.
 - f. Ducted Fan Connections: 6 diameters downstream, 3 diameters upstream.
 - g. Plenum Fan Connections: 5 diameters downstream, 3 diameters upstream.

7. Include with the bid one each of any necessary configuration tools required to set up the meter if the setup cannot be accomplished from the meter electronics package itself to be turned over to the Owner upon project completion.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification [and on face of ceiling directly below instruments concealed above ceilings]. Comply with requirements for identification specified in Section 20 10 70 "Identification for Mechanical Systems."

3.5 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed surfaces.

END OF SECTION 25 20 00

SECTION 25 30 00 – HYDRONIC CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Temperature Measurement
 - 2. Pressure Measurement
 - 3. Control Valves
 - 4. Flow Measurement
 - 5. Water Level Sensors
 - 6. Auxiliary equipment
- B. Related Requirements:
 - 1. Section 25 00 00 TEMPERATURE CONTROL SYSTEM

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 INSERTION ELEMENT FLUID TEMPERATURE SENSOR

- A. Sensor shall be tip sensitive 10,000 ohm Thermistor or 1,000 ohm RTD. Sensors shall be 6" long, with either 3/8" or 1/4" diameter screwed or smooth shanks.
- B. Thermistor element shall be 10,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, $\pm 1\%$ at 25°C or $\pm 0.36^\circ\text{F}$ accuracy.
- C. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, $\pm 1\%$ at 25°C or $\pm 0.36^\circ\text{F}$ accuracy.
- D. The housing shall be a weather tight cast aluminum utility box and stamped aluminum cover with a full gasket, or UV-resistant polycarbonate box with hinged cover and thumb latch.
- E. Acceptable sensors are Precon KTW Series, BAPI BA/10K(1K) or approved equivalent.

2.3 INSERTION ELEMENT FLUID TEMPERATURE SENSOR WITH TRANSMITTER

- A. Sensor shall be 100 ohm platinum RTD combined with a 4-20 mA transmitter factory matched and calibrated.
- B. The element shall be 100 ohm platinum of 0°C, with a reference temperature coefficient of resistance equal to 0.00385 ohm/ohm/°C, Class B ± 0.12 ohm at 0°C, per IEC Standard 751. RTD element may be a 2-wire or 3-wire type. RTD probes shall be 6" long with either 3/8" or 1/4" diameter.
- C. The transmitter shall be a high quality HVAC grade with an accuracy of $\pm 0.1\%$ of full scale or better (including linearity, hysteresis, and repeatability) referenced to mV input, with a drift of 0.1% of span per year or less. The transmitter shall be for a 100 ohm platinum RTD input and with a 4-20 mA output.
- D. The housing shall be a weather tight cast aluminum 'LB' elbow or utility box, stamped aluminum cover, with a full gasket.
- E. The RTD shall be factory calibrated to the specified ranges using a minimum of (3) points. Unless otherwise indicated the range shall be: 30°F - 80°F for chilled water, 30°F - 120°F for condenser water, and 30°F - 250°F for heating water and domestic hot water.
- F. Chilled water transmitters shall be "sensor matched" and calibrated (with temperature) as an assembly with the actual RTD connected, for an accuracy of $\pm 0.1^\circ\text{F}$ plus 0.1% of span referenced to the actual temperature input.
- G. Acceptable sensors are Weed model 723, Minco model S479PD, RdF model 2801, Graystone series TE500, or approved equivalent.

2.4 STRAP-ON THERMOSTAT (AQUA-STAT):

- A. Thermostat shall be strap-on style, affixed to the outside of the humidifier condensate piping, under the pipe insulation. Sensor shall be liquid bulb, 100° - 240°F setpoint range, fixed 10°F differential, SPDT snap-acting switch and setpoint adjustment knob.
- B. Thermostat shall change state when pipe temperature is above setpoint. The contacts shall be rated for 10 A resistive at 120 VAC. The normally closed contacts shall be wired to the humidifier safety circuit.
- C. The thermostat shall automatically reset when sensed temperature is below setpoint.
- D. Thermostat shall be JCI Model A19DAC-1 or approved equal.

2.5 HYDRONIC DIFFERENTIAL PRESSURE TRANSMITTER

- A. The transmitters shall be a high quality HVAC grade with an accuracy of +/- 0.25% of full scale or better (including linearity, hysteresis, and repeatability) with a drift of 0.5% of span per year or less. All wetted parts shall be 316 stainless steel for long life. Units shall be rated for an operating static pressure of 100 psig.
- B. Enclosure shall be NEMA 4 weather tight construction with ½" conduit connection and 1/8" NPT process connections.
- C. If not designated otherwise on the Points List, sensor ranges shall be as follows:
- D. Pressure transmitters at pumps or in central plant mechanical rooms shall be 0-25 psid.
- E. Pressure transmitters located at end-of run equipment for pump control shall be 0-10 psid.
- F. Acceptable manufacturers are Setra model 230 with 3-valve manifold, Graystone model WP-D, or approved equivalent.
- G. Transmitters that utilize independent pressure transducers on the high and low pressure lines are not allowed.

2.6 HYDRONIC GAUGE PRESSURE TRANSMITTER

- A. The transmitters shall be a high quality HVAC grade with an accuracy of +/- 0.25% of full scale or better (including linearity, hysteresis, and repeatability) with thermal effects of zero shift of +/- 2.0%/100°F and +/- 1.5%/100°F. All wetted parts shall be 17-4 PH stainless steel for long life. Units shall be rated for shock of 200g operating, as tested per Mil-Std. 202, Method 213B, Cond. C.
- B. Provide terminal block with conduit cover enclosure option and 1/8" MNPT process connection.
- C. Sensor range shall be as indicated on Notes column of Points List.

- D. Acceptable manufacturer is Setra model 209, or approved equivalent.

2.7 CONTROL VALVES

- A. In general, the following types of valves shall be used unless otherwise indicated: Cooling valves shall be ball valves for 3" and smaller, and butterfly valves for 4" and larger. Hydronic heating valves shall be ball valves for 3" and smaller, and butterfly valves for 4" and larger. Steam heating valves shall be globe valves for all applications. [Heating and cooling valves on unitary terminal equipment shall be ball-type zone valves.]
1. Globe valves shall be Belimo, Schneider Electric, Johnson, Siemens or equivalent. Globe valves shall be threaded bronze body or flanged cast iron body, stainless steel stem, brass plug, composition disk, bronze seat, rated at 250 psi working pressure, and 35 psi differential pressure.
 2. Ball valves shall be Belimo, Siemens, or Bray. Ball valves shall be threaded bronze body, chrome plated ball, blowout proof stem, Teflon seat, rated at 600 psi W-O-G working pressure, and 35 psi differential pressure.
 3. [Ball-type zone valves shall be Belimo. Ball-type zone valves shall be threaded forged brass body, chrome plated brass ball, brass stem, Teflon seat, rated at 360 psi, and 75 psi differential pressure.]
 4. Butterfly valves shall be Belimo or Bray. Butterfly valves shall be lug body style, cast iron body, aluminum bronze disk, EPDM seats, and stainless steel shaft. Valves to be selected for maximum open position of 60°.
- B. Valve actuator requirements shall be as follows.
1. Torque rating shall be based on the valve manufacturers operating torque requirements at the design flows and pressure drops or shall be based on the manufacturers required shut off torque to achieve 100% flow shut off at pump shut off head on the system in which they are installed, whichever is greater.
 2. For exterior located valves, torque ratings shall be based on 0°F outside ambient temperature.
 3. For power-failure/safety applications, a mechanical, spring return mechanism shall be used. Non-mechanical forms such as battery back-up and capacitor discharge, are not acceptable. The normal position is the position that the actuator must fail to upon loss of control signal or power.
 4. In general the following types of actuators shall be used unless otherwise indicated: Proportional spring return valves (4-20 mA, 0-10 VDC, 3-15 psi) will be used for heating coils on units with outdoor air connections and heat exchangers, refer to sequences or points list for fail-safe position. Proportional non-spring return valves (4-20 mA, 0-10 VDC, 3-15 psi) will be used for cooling coils and reheat coils. Triac or floating valves will only be allowed on VAV box reheat coils, fan coil units, terminal heating equipment, etc.
 5. Two position valves shall be the full size of the pipe they are associated with unless otherwise specified.
 6. Two way valve actuators shall be sized to close off tight against the full pump shut off head on the system in which they are installed.
 7. Three way valve actuators shall be sized to close off tight in both directions against 2.5 times the valve pressure drop at full flow.
 8. Electrical actuated valves shall be provided with Belimo, Bray or Siemens actuators. Actuators shall have current limiting circuitry incorporated in its design to prevent damage

to the actuator. A gear release shall be provided on the motor to allow for manual override. Modulating actuators shall be rated for a 4-20 mA input signal. Actuators shall be rated for 24 VAC power. The units shall have visual mechanical position indication showing output shaft and valve position.

C. Modulating valve sizing shall be based on the following conditions.

1. General
 - a. Flow rates for valve sizing shall be based upon the flow rates indicated on the equipment schedules on the drawings.
 - b. Valve sizing shall consider the valve cavitation coefficient. In no case shall a valve be sized so that the pressure drop through the valve causes cavitation with fluid temperatures and pressures encountered in the system during start up or normal operation. If cavitation is possible in a single valve, select two control valves to be piped in series to avoid cavitation.
2. Water Valves:
 - a. Minimum pressure drop 3 psi or equivalent to the waterside pressure drop of the coil it is associated with, whichever is greater.
 - b. Maximum pressure drop 5 psi.
3. Steam Valves:
 - a. For valves in service on lines at or under 35 psig, target pressure drop is 42% inlet absolute pressure.
 - b. For valves in service on lines above 35 psig, target pressure drop is 80% inlet gauge pressure.
 - c. Valves shall be sized below critical Cv to prevent choked flow.

2.8 FLOW MEASUREMENT

A. Insertion Electromagnetic Fluid Flow Measurement

1. Technology: Insertion electromagnetic
2. Range: 0.1 ft/sec to 20 ft/sec
3. Accuracy: +/-1% of reading between 2-20 ft/sec; +/-0.02 ft/sec below 2 ft/s
4. Pipe sizes: 4" and Larger
5. Output: 4-20 mA signal proportional to line velocity
6. Installation: 1-1/4" thread-o-let (1-1/2" for hot tap) installed by the Mechanical Contractor. Provide adequate room for removal/installation of meter
7. Flow meter shall be Onicon F-3500.

B. Full Body Electromagnetic Fluid Flow Measurement

1. Technology: Full Body Electromagnetic
2. Range: 0.1 ft/sec to 33 ft/sec
3. Accuracy: +/-0.4% of reading between 3.3-33 ft/sec; +/-0.8% of reading between 1-3.3 ft/sec; +/-0.0075 ft/sec below 1 ft/s
4. Pipe sizes: 1/4" – 3", or where specifically indicated on Drawing Flow Meter Schedule for application.
5. Connection: [Wafer, 150lb Flanges] Output: 4-20 mA signal proportional to line velocity
7. Installation of flow meter in non-conductive pipe requires the addition of grounding rings on the upstream and downstream connections of the flow meter to the piping system.
8. Flow meter shall be Onicon F-3100.

- C. Strap-on Ultrasonic Fluid Flow Measurement
1. Technology: Strap-on Ultrasonic transit time
 2. Range: 0.1 ft/sec to 40 ft/sec
 3. Accuracy: +/-1% of reading between 1-40 ft/sec; +/-0.01 ft/sec below 1 ft/s
 4. Pipe sizes: 1/2" and Larger
 5. Output: 4-20 mA signal proportional to flow rate
 6. Installation: Locate sensor heads in the orientation and distance for the pipe size. Couple using provided gel. Only use factory cables between sensor heads and meter.
 7. Flow meter shall be Onicon F-4300, Dynasonics TFX Ultra, or Flexim Fluxus F721.
- D. Full Body Vortex Shedding Fluid Flow Measurement
1. Technology: Full Body Vortex Shedding, pressure and temperature compensated
 2. Range: 10 - 250 ft/sec
 3. Mass Flow Rate Accuracy: +/-1.5% of reading
 4. Pipe sizes: 1/2" thru 12"
 5. Connection: [Wafer, 150lb Flanges, 300lb Flanges]
 6. Output: 4-20 mA signal proportional to mass flow rate
 7. Flow meter shall be Onicon F-2600.
- E. Insertion Vortex Shedding Fluid Flow Measurement
1. Technology: Insertion Vortex Shedding, pressure and temperature compensated
 2. Range: 10 - 250 ft/sec
 3. Mass Flow Rate Accuracy: +/-2% of reading
 4. Pipe sizes: 2" and larger
 5. Connection: [2" NPT] [2" Flanged 150lb, 300lb] with retractor
 6. Output: 4-20 mA signal proportional to flow mass rate
 7. Installation: 2" Flange (1-1/2" for hot tap) installed by the Mechanical Contractor. Provide adequate room for removal/installation of meter
 8. Flow meter shall be Onicon F-2700.
- F. Insertion Thermal Dispersion Fluid Flow Measurement
1. Technology: Insertion Vortex Shedding, pressure and temperature compensated
 2. Range: 5 - 7000 SFPM
 3. Mass Flow Rate Accuracy: +/-1% of reading 500-7000 SFPM; +/-2% of reading 100-500 SFPM
 4. Pipe sizes: 1" and larger
 5. Output: 4-20 mA signal proportional to flow mass rate
 6. Installation: 3/4" thread-o-let installed by the Mechanical Contractor. Provide adequate room for removal/installation of meter
 7. Flow meter shall be Onicon F-5100.
- G. Flow Cone Fluid Flow Measurement –
1. Technology: Differential pressure
 2. Range:
 3. Mass Flow Rate Accuracy: The pressure transmitter shall be selected to produce a maximum error +/- 2% of output over the entire 10:1 flow meter turn down. The minimum range of the pressure transmitter shall be 200" w.c. to allow 140% of design flow. The Flow Cone calibration curve shall have a range of 200" w.c. to 1" w.c.
 4. Pipe sizes: 1" and larger

5. Connection: [Wafer, 150lb Flanges, 300lb Flanges]
6. Body: Coated Schedule 40 carbon steel pipe
7. Output: 4-20 mA signal proportional to flow mass rate
8. Installation: Three valve manifold and all required piping and valves at each flow cone location
9. Flow cones shall be as manufactured by McCrometer.

2.9 ELECTRONIC FLOW SWITCH

- A. Furnish and install electronic flow switches as specified herein and shown on the drawings.
- B. Sensor shall consist of a reference temperature probe and a heated temperature probe. The differential in temperature varies as the flow changes across the sensor. The sensor shall have a range of 0.5 to 5 fps. The trip set point shall be adjustable via a potentiometer on the circuit board.
- C. The unit shall have a SPDT relay switch output with options for power input of 120 VAC, 24 VDC or VAC, or 240 VAC.
- D. The housing shall be a general purpose LB enclosure with 1" FNPT electrical connection and 1" MNPT connection to the process piping.
- E. Units shall be Ameritrol, Inc. Model FM-1000-voltage-02-S or approved equivalent.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing conditions....

3.2 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

- A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.
- B. Deliver the products specified in this section and related accessories to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.

3.3 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.

- C. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

A. Mounting Location:

1. Rough-in: Outline instrument-mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
2. Install switches and transmitters for air and liquid flow associated with individual air-handling units and connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
3. Install liquid and steam flow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install airflow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
6. Install instruments in steam, liquid, and liquid-sealed-piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.
7. Install instruments in dry gas and non-condensable-vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.

B. Mounting Height:

- C. Mount remote displays, switches and transmitters, located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements, within a range of 42 to 72 inches (1050 to 1800 mm) above the adjacent floor, grade, or service catwalk or platform.

1. Make every effort to mount at 60 inches (1500 mm).

- D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

3.5 INSTALLATION OF INSERTION ELEMENT FLUID TEMPERATURE SENSOR

- A. Provide sensors locations as indicated on the plans, flow diagrams, details, specifications, and sequence of operation. [When two (2) wells are shown at the same location: One well will be installed for the sensing element. The second well will be installed to allow a separate calibration instrument to be used to calibrate the sensor without removing it from the line; it shall have a cap and chain for protection when not in use.]

- B. Temperature sensor immersion well [and calibration wells (see above)] shall be [brass or 316 SS] [316 SS] 3/4" NPT or 1/2" NPT pipe connection size with 1/2" NPT female threads. Thermometer wells shall have an overall length of 6". For larger pipe the fluid insertion length shall be 4-1/2". For smaller pipes the insertion length shall be 2-1/2" with a 2" lag length. For general use, a straight stepped shank may be used, provided it is less than 70% of the manufactures critical velocity rating, otherwise use a heavy duty tapered shank to meet the required stiffness. Sensor wells internal bore shall match sensor provided; [calibration wells shall have 3/8" internal diameter].
- C. The contractor shall be responsible for coordination, with the installing trade contractor of the other sections of the specification, the location of all thermometer wells and insertion depths required by this section. The tip of the sensor shall be completely in the process fluid. Thread-o-lets and any required bushings shall be coordinated the installing trade contractor. Sensor shall be installed with thermally conductive paste equal to Omegatherm -201 manufactured by Omega Engineering.

3.6 INSTALLATION OF STRAP-ON THERMOSTAT

- A.

3.7 INSTALLATION OF DIFFERENTIAL PRESSURE SENSOR

- A. The contractor shall provide for installation by others, isolation valves, snubbers, and access fittings to be used at all pressure transmitter and pressure sensor locations. The connections shall be configured by the installer so that the isolation valve isolates the sensor and calibration port (Pete's plug, Schraeder valve, or access fitting) from the process monitored.

- B. [At 3 or 5 valve manifolds provide an engraved 4" x 3" nameplate, white letters on a red background:

WARNING: OPEN EQUALIZING VALVES PRIOR TO OPENING OR CLOSING THE SERVICE VALVES THAT CONNECT THIS TRANSMITTER TO THE PROCESS LINE.]

- C. This section shall be responsible for coordination of the installation of all pressure sensor taps required under this section of the specification with other sections of the specification.

3.8 INSTALLATION OF CONTROL VALVE

- A. Install pipe reducers for control valves smaller than line size. Position reducers as close to control valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.
- B. Install flanges or unions to allow drop-in and -out valve installation unless otherwise indicated.
 - 1. Do not provide unions for terminal equipment with copper pipe.
- C. Test Plugs: Install pressure temperature test plugs in piping upstream and downstream of each control valve larger than 2" and where indicated on flow diagram or details.

- D. Valve Orientation:
 - 1. Where possible, install valves that are installed in horizontal piping, with stems upright and not more than 15 degrees off of vertical, not inverted.
 - 2. Install valves in a position to allow full stem movement.
- E. Clearance:
 - 1. Locate valves for easy access, and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
 - 2. Install valves with at least 12 inches of clear space around valve and between valves and adjacent surfaces.
- F. Threaded Valves:
 - 1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
 - 2. Align threads at point of assembly.
 - 3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
 - 4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.
- G. Flanged Valves:
 - 1. Align flange surfaces parallel.
 - 2. 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 with a torque wrench.

3.9 INSTALLATION OF FLOW INSTRUMENTS

- A. Install meters in straight sections of piping with manufacturer-recommended straight piping upstream and downstream of sensor.
- B. Install pipe reducers for in-line meters smaller than line size. Install reducers at distance from meter to avoid interference and impact on accuracy.
- C. Install in-line meters with flanges or unions to provide drop-in and -out installation.
- D. Insertion Meters:
 - 1. Install system process connections full size of meter connection and meter manufacturer requirements, but not less than NPS 1-1/2". Provide NPT threaded bushing, the same material as the piping, if required by installation.
 - 2. Install meter in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
 - 3. In applications where top-dead-center location is not possible due to field constraints, install meter at location along top half of pipe if acceptable by manufacturer for mounting orientation.

3.10 INSTALLATION OF ELECTRONIC FLOW SWITCH

- A. Install system process connection full size of switch connection, but not less than NPS 1". Provide NPT threaded bushing, the same material as the piping, if required by installation.
- B. Install switch in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
- C. In applications where top-dead-center location is not possible due to field constraints, install switch at location along top half of pipe if switch is acceptable by manufacturer for mounting orientation.

3.11 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

END OF SECTION 25 30 00

SECTION 25 40 00 – AUXILIARY EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: List
- B. Related Requirements:
 - 1. Section 25 00 00 TEMPERATURE CONTROL SYSTEM

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A.

2.3 CURRENT OPERATED SWITCHES

- A. Adjustable Trip Current Switch
 - 1. General: Adjustable trip current switches shall be used on belt driven or coupled equipment. Switches shall be provided with mounting hardware, and securely mounted

and located such that they are easily adjustable without the possibility of shock from the starter components.

2. Current operated switch shall be capable of changing the state of an isolated dry contact or switch when a flow of current is sensed in the wire they are monitoring. The isolated output must be rated at 1 A at 30 VAC or VDC, they shall incorporate a status LED, and shall be UL listed. Trip points shall be between 0.5 A to 135 A, depending on motor size and application. Acceptable manufacturers and models are Veris H308, Veris H908, Functional Devices RIBXGH Series.

B. Fixed Trip Current Switch

1. General: Fixed trip current switches shall be used on direct drive equipment. Switches shall be securely mounted and located such that they are easily adjustable without the possibility of shock from the starter components.
2. Current operated switch shall be capable of changing the state of an isolated dry contact or switch when a flow of current is sensed in the wire they are monitoring. The isolated output must be rated at 1 A at 30 VAC or VDC, they shall incorporate a status LED, and shall be UL listed. Trip points shall be between 0.5 A to 135 A, depending on motor size and application. Acceptable manufacturers and models are Veris H300, Veris H900, Functional Devices RIBXGH Series.

- C. Current Switch Integral Command Relay: Current operated switches may be provided with integral command relays as required to perform the indicated functions in the sequences of operation at the contractor's option. In addition to the requirements set forth above for the current switch, relay contacts shall be SPST, rated for 5 A at 250 VAC minimum, sized for the application.

2.4 CONTROL POWER TRANSFORMERS

A. 24 VAC Control Power Transformers

1. Transformers shall be NEC Class 2 general purpose transformers with primary windings as required by the application and 24 VAC secondary windings rated for 40 VA at 100% power factor. Transformers shall be installed in a suitable enclosure to prevent contact with the primary and/or secondary terminals when the cover is on the enclosure. Where transformers are provided for installation by others, the transformers shall be provided mounted in the enclosure. The mounting arrangement shall be such that the terminals are accessible for connection without removing the transformer from the enclosure.
2. Transformers with higher VA ratings may be supplied but must be designed and installed to meet all requirements of NEC article 725 when used to serve Class 1, Class 2, or Class 3 low voltage circuits.
3. Where fuses are provided, a minimum of two (2) spare fuses of the same type and rating at each location.

B. 24 VAC Control Power Load Centers

1. Control Power Load Centers are used for distributed 24 VAC power supply of terminal control devices.
2. Load Centers shall have NEC Class 2 rated secondary winding circuit distribution. General purpose transformers up to 500 VA shall have 480/277/240/120 VAC primary windings and 24 VAC secondary windings. Primary input terminals shall be finger-safe. Secondary winding distribution shall have circuit breakers to provide 4 Amp overcurrent protection

on isolated circuits. Each secondary winding distribution circuit shall have an isolation switch, status indicator light, and screw terminals for termination. Load Center shall be provided with NEMA 1 metal enclosure.

3. Load Center shall be Function Devices model PSH500A or approved equivalent.
4. Load Centers are provided by the Division 25 Contractor, secondary wiring is provided and performed by the Division 25 Contractor, primary wiring and conduit is provided and performed by the Division 26 Contractor.

2.5 PRESSURE SWITCHES

- A. Air Differential Pressure Switch: Switches shall be arranged to actuate a snap acting single pole double throw switch based on the difference between two pressures as sensed by a diaphragm. The setpoint shall be adjustable between 0.05" w.c. and 12.0" w.c., with a progressive switching differential between 0.02" w.c. \pm 0.01" w.c. at minimum setpoint to 0.8" w.c. at maximum setpoint. Switch shall be rated to operate in ambient temperature of -40°F – 180°F, and diaphragm shall be rated for a maximum pressure of 0.5 psig. Switches shall be rated for a minimum of 300 VA pilot duty at 115 – 277 VAC, 15 A non-inductive load up to 277 VAC. Switches shall be rated for 100,000 cycles at maximum operating pressure and maximum electrical load. Enclosures shall be rated NEMA 1 and shall be provided with conduit connection and 1/4" compression piping connections. Switches shall be Cleveland Controls model AFS-222 or approved equal.
- B. Manual Reset Air Differential Pressure Switch: Switches shall be arranged to actuate a snap acting single pole single throw normally closed switch based on the difference between two pressures as sensed by a diaphragm with a manual reset button. The setpoint shall be adjustable between 0.40" w.c. \pm 0.06" w.c. and 12.0" w.c., with a progressive switching differential between 0.06" w.c. \pm 0.01" w.c. at minimum setpoint to 0.8" w.c. at maximum setpoint. Diaphragm shall be rated for a maximum pressure of 0.5 psig. Switches shall be rated for a minimum of 15A at 115 – 277 VAC. Switches shall be rated for 6,000 cycles at maximum operating pressure and maximum electrical load. Enclosures shall be rated NEMA 1 and shall be provided with conduit connection and 1/4" compression piping connections. Switches shall be Cleveland Controls model AFS-460 or approved equal.
- C. Air Differential Pressure Switch Sensing Probe: For all pressure sensing locations that are remote from the pressure switch, provide an appropriate static pressure sensing probe as described below. Connections between differential pressure switch and static pressure probes shall be made with 1/4" polyethylene tubing for all runs under 10 feet. For runs longer than 10 feet, run 1/4" OD, 0.020" wall hard copper tubing with solder fittings. Terminate ends of copper tubing with 1/4" ID to 1/4" barbed adapter or 1/4" compression to 1/4" compression coupling for polyethylene final connections (within 9") to device. Where compression fittings are used, use plastic tubing inserts for polyethylene tubing. Polyurethane tubing may not be used in any exposed applications, only within a control panel as it is not plenum rated.
- D. For unit or duct mounted pressure sensing locations, provide static pressure probe with 1/4" brass barb or compression connection and gasketed mounting flange. Static pressure probe shall be Mamac model A-520, Dwyer model A-489/491/493, or approved equal.
- E. Hydronic Differential Pressure Switch: Switches shall be arranged to actuate a single pole double throw switch based on the difference between two pressures. Switches shall be bellows actuated.

Switches shall be suitable for the working pressure of the system on which they are installed and shall have a minimum working pressure rating of 30 inches Hg vacuum to 100 psig. The setpoint shall be adjustable between 0 and 20 psig and the sensitivity shall be adjustable with a minimum setting of 1 psig. Switches shall be rated for a minimum of 5 amps at 120 VAC. Enclosures shall be rated NEMA 1 and shall be provided with termination points for conduit and piping connections. Switches shall be Mercoid series DPA or approved equal by United Electric or Penn.

2.6 ELECTRONIC TO PNEUMATIC SIGNAL CONVERTERS

- A. Signal converters shall convert an analog electronic signal (4-20 mA, 1-10 VDC, etc.) to a directly proportional 0-15 psi pneumatic signal for use in modulating pneumatic actuators. Converters shall be Kele UPC 422 or approved equal as manufactured by VDO.

2.7 TERMINAL BLOCKS

- A. Fuse Holder Terminal Blocks: Terminal block shall be arranged to allow a fuse to be installed in the terminal strip between the entering and leaving wires of the termination point. Terminals shall be provided with LED, Neon, or mechanical fuse status indicators. Terminals shall be rated for the voltage and current of the circuit they are contained in at a minimum. Terminals shall be suitable for and mounted on a standard DIN EN 50022 mounting rail. Provide with accessories as required for a complete assembly. Acceptable models and manufacturers are as follows: Weidmuller SAKS Series, Entrelec MB10/12 Series, Phoenix UK5 Series.
- B. Feed Through Terminal Blocks: Feed through terminal blocks shall be compatible with the special purpose terminals specified above and shall mount on the same DIN rail system. Terminals shall be clamp type terminals suitable for solid or stranded wire from #18 AWG to #12 AWG (minimum range). Terminals shall be rated for the voltage and current at which they are applied and shall be provided with all necessary end caps, separators, etc., required for a complete installation.
- C. [Disconnecting Terminal Blocks: Terminal block shall be arranged to allow the entering conductor to be disconnected from the leaving conductor without lifting the conductor from its termination point. Disconnection shall be by screw driver actuated sliding link, knife link, or plug switch. Terminals shall be rated for the voltage and current of the circuit they are contained in at a minimum. Termination points shall be arranged with test jacks to allow a meter to be connected without interfering with the operation of the disconnecting means. Terminals shall be suitable for and mounted on a standard DIN EN 50022 mounting rail. Provide two spare fuses of the same type and rating at each location. Provide with accessories as required for a complete assembly. Acceptable models and manufacturers are as follows: Weidmuller SAKC10, Weidmuller SAKT1, Weidmuller SAKT2, Entrelec 4/6.SNT, Entrelec M6/8.ST2, Phoenix URTK/SP, Phoenix MTK-P/P, Phoenix UK4-TP.
- D. Grounding Type Terminal: Terminals shall be color-coded green and yellow and shall be compatible with the other specialty terminals specified above and shall mount on the same DIN rail system. Units shall be arranged so that the wiring connected to them is grounded to the enclosure via the mounting rail. Terminals shall be Phoenix USLKG, MSLKG, or equivalent as manufactured by Wiedmuller or Entrelec. These terminals shall be provided for grounding cable shields at the points where the cables enter a control panel and terminate on the control panel terminal strip.

- E. Resistor Style Terminal Block: Terminals shall be arranged for mounting on a standard DIN mounting rail and shall be provided with the appropriate resistor value and tolerance either factory or field installed. Terminals shall consist of a two level block with the upper terminals bussed together and the lower terminals bussed together. A resistor of the appropriate value and tolerance as required by tea application and/or as indicated on the drawings shall be installed between the upper and lower busses. The terminals shall be applied where it is desired to pass a current loop through a series load resistor to generate a voltage drop for use by a control system or an indicator. Terminals shall be Allen Bradley 1492-UW5R, 1492-H2RA, B, or C, Phoenix UDK4-DUR, or equivalent models by Wiedmuller or Entrelec.]

2.8 RELAYS

A. Plug-In General Purpose Relays

1. Application: Plug-in general purpose relays shall be used in auxiliary panels and in controlled device power enclosures. Application may be for duplication of a signal for multiple devices, or for segregation of operating voltage of controlled devices.
2. Description: Blade style 3PDT relay with socket and LED or mechanical indicator. Coil nominal (rated) voltage shall be dictated by application requirements, shall withstand 110% rated voltage continuous, have pull-in voltage of 80% of rated voltage, drop-out voltage of 30% rated voltage, and resistance of 103 ohms at 24 VAC / 10,800 ohms at 120 VAC. Contacts shall be silver cadmium oxide, rated for 7.5A at 120 VAC resistive load. Relays shall be Idec RH series with SH series socket or approved equal.

B. Track Mounted Relays

1. Application: Track mounted relays are allowed for use in controlled device power enclosures whose space limitations prevent the use of plug-in relays, or for whose configuration prevent the use of enclosed relays.
2. Description: Track mounted relay with LED indicator, dual voltage coil for 24 VAC or 120 VAC, SPDT contact rated for 10A at 120 VAC resistive load. Relays shall be Air Products and Controls MR-800 series, Functional Devices RIMMNU1C, or approved equal.

C. Enclosed Relays

1. Application: Enclosed relays shall be used at controlled device power enclosures for remote operation of equipment.
2. Description: Enclosed relay with LED indicator, dual voltage coil for 24 VAC or 120 VAC, SPDT contact rated for 10A at 277 VAC resistive load. Relays shall be Functional Devices RIBU1C or approved equal.

D. Fan Safety Alarm Circuit Relays

1. Application: Fan safety alarm circuit relays are permitted for use of fan hardwired interlocks at the contractor's option. If used, they shall be mounted in the auxiliary panel in which the air handling unit's controller is mounted.
2. Description: Track mounted relay with LED indicators for power, master relay on, and status of input safeties, 24 VAC supply power (at 4A), SPST actuator control contact rated for 3A at 24 VAC, SPST fan safety control contact rated for 750 mA at 24 VAC, and one SPST dry contact for each monitored safety. Relays shall be Functional Devices RIBMNLB or approved equal.

- a. For application with automatic reset low limit thermostats (see section 25 21 01), set board jumpers to enable latching circuit and manual reset button on low limit thermostat relay input.
- E. Network Compatible Relays
1. Application: Network compatible relays are permitted for use only as specifically identified on the drawings, points list, or as expressly allowed by the engineer.
- F. Time Delay Relays
1. Application: Time delay relays should normally be avoided, time delays shall be accommodated in programming where possible. In the event that time delay relays are required for a specific application, they shall be mounted in the auxiliary panel that has the controller for the controlled equipment, or in a specifically fabricated panel for the controlled equipment that is approved by the engineer.
 2. Description: 11-blade style plug in relays requiring 24 VAC power supply, signal-triggered timing circuit, selectable timing functions (on-delay, off-delay, one-shot), adjustable time delay setting between 0.1 s – 600 hours, Form C output contacts, power and timer LED indicators, and UL listed. Relays shall be Idec RTE-B2 series or approved equal.
- G. Latching Relays
1. Application: Latching relays are normally not used, except in applications where automatic reset low limit thermostats are allowed (see section 25 21 01) and the Fan Safety Alarm Circuit Relay is not used, where specifically required by the points list or sequence, or as specifically approved by the engineer.
 2. Description: Blade style plug-in latching relay with permanent magnet self-holding function, with set and reset coils, check button, 3 A at 250 VAC. Relays shall be Idec RY2KS-UC or approved equal.
- H. Relay & AC Current Switch Combo
1. Application: Enclosed relays & AC current switch combos shall be used at controlled device power enclosures for remote operation of equipment when status feedback is required.
 2. Description: Enclosed relay/ac switch combination with adjustable threshold and override switch, solid state contact output, 24 VAC coil, SPDT contact rated for 20A at 277 VAC resistive load. Relays shall be Functional Devices RIBX24SBA or approved equal.
- 2.9 DAMPER END SWITCHES
- A. Damper End Switches
1. End switches used for damper permissive fan safety circuits shall be safety limit switches, heavy-duty NEMA style, plug-in body. Enclosure shall be NEMA 4, 13 with ½" EMT conduit connection and ambient temperature rating 0°F to 230°F. Actuator head shall be rotary style, CW and CCW actuation, spring return, 4 in-lb operating torque, 13° max travel to operate contacts, 7° max travel to reset contacts, 90° max travel. Switch shall have two snap-acting contacts, 1 N.O. and 1 N.C., 30A make at 120 VAC, 3.0A break at 120 VAC, 5A at 120 VAC continuous operating current. Operating lever shall be adjustable lever, 1.19 in. to 3 in. radius, with 0.63" diameter by 0.25" thick nylon roller (min.). End switch shall be Allen-Bradley 802T-AP or Square D 9007C54B2.

2. End switch and operating lever shall be installed such that contacts prove when damper blade is at 95% open. Operating lever roller shall contact damper blade directly, no contact with damper seal is acceptable. Where end switch cannot be directly mounted to duct wall, provide 12 gauge galvanized steel mounting bracket. Operating lever shall be Allen-Bradley 802T-W2 or Square D 9007HA23.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing conditions....

3.2 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

- A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.
- B. Deliver the products specified in this section and related accessories to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.
- C. Deliver the products specified in this section and related accessories to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.

3.3 INSTALLATION

3.4 INSTALLATION OF CURRENT SWITCHES

- A. For variable speed applications, trip point shall be set with motor at full speed under normal loading conditions (connected to system of service).
- B. For variable speed applications, following trip point set at motor full speed, verify proof of operation at motor minimum speed. If current range between minimum and maximum speed prevents reliable proof indication in a single current switch, provide two switches (one for minimum speed and one for maximum speed) and program logic to accommodate proper status indication.
- C. Split core current switches are preferred due to their ability to be changed without removal of phase conductors when the equipment has been placed into service. Solid core current transformers will be considered if there are space constraint considerations.
- D. If motor current draw is less than listed minimum trip point for the current switch, wrap phase conductor around current switch the minimum number of passes to reach threshold trip current.

3.5 CLEANING AND PROTECTION

A. Clean

END OF SECTION 25 40 00

SECTION 25 50 00 – WIRING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Raceways
 - 2. Wiring
- B. Related Requirements:
 - 1. Section 25 00 00 TEMPERATURE CONTROL SYSTEM
 - 2. Section 26 00 00 ELECTRICAL
 - 3. Section 27 00 00 COMMUNICATIONS

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 CONTROL WIRE AND CABLE

- A. Wire: Single conductor control wiring above 24 V.
 - 1. Branch Circuits: Minimum 12 AWG.
 - 2. Motor Interlock Wiring: Minimum 14 AWG.

3. Conductors: 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
 4. Conductor Insulation: 600 V, Type THWN or Type THHN, and 90 deg C in accordance with UL 83.
 5. Conductor Insulation Colors: Black (hot), white (neutral), and green (ground).
 6. Furnish on spools.
- B. Single, Twisted-Shielded, Instrumentation Cable above 24 V:
1. Wire Size: Minimum 18 AWG.
 2. Conductors: Twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
 3. Conductor Insulation: Type THHN/THWN or Type TFN rating.
 4. Conductor Insulation Colors:
 - a. Twisted Pair: Black and white.
 - b. Twisted Triad: Black, red, and white.
 5. Shielding: 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
 6. Outer Jacket Insulation: 600 V, 90 deg C rating, and Type TC cable.
 7. Furnish on spools.
- C. Single, Twisted-Shielded, Instrumentation Cable 24 V and Less:
1. Wire Size: Minimum 22 AWG.
 2. Conductors: Twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch (50- to 65-mm) lay.
 3. Conductor Insulation: Nominal 15-mil thickness, constructed from flame-retardant PVC.
 4. Conductor Insulation Colors:
 - a. Twisted Pair: Black and white.
 - b. Twisted Triad: Black, red, and white.
 5. Shielding: 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
 6. Outer Jacket Insulation: 300 V, 105 deg C rating, and Type PLTC cable.
 7. Furnish on spools.
- D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.
1. Comply with following requirements for balanced twisted pair cable described in Section 27 15 13 "Communications Copper Horizontal Cabling."
 - a. Category 6
 - b. Plenum rated.
 - c. Unique color that is different from other cables used on Project.

2.3 RACEWAYS

- A. Comply with Section 26 05 33 "Raceway for Electrical Systems," Section 26 05 34 "Boxes for Electrical Systems," for installation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- C. Examine roughing-in for instruments installed in duct and piping systems to verify actual locations of connections before installation.
- D. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- 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.

3.2 INSTALLATION OF CONTROL WIRE, CABLE, AND RACEWAY

- A. Comply with NECA 1.
- B. Wire and Cable Installation:
 - 1. Comply with installation requirements in Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables" for Power wiring and grounding.
 - 2. Comply with installation requirements in Section 27 15 13 "Communications Copper Horizontal Cabling" or LAN cabling.
 - 3. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
 - a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
 - 4. Terminate wiring in a junction box
 - a. Clamp cable over jacket in a junction box.
 - b. Individual conductors in the stripped section of cable is to be slack between the clamping point and terminal block.
 - 5. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
 - 6. Install signal transmission components in accordance with IEEE C2, REA Form 511a, NFPA 70, and as indicated.
 - 7. Use shielded cable to transmitters.
 - 8. Use shielded cable to temperature sensors.
 - 9. Motor Interlock Wiring:

- a. Stranded control wire shall be provided with crimp type spade terminators. Interlock circuit wiring shall be color-coded or numbered using an identical number on both ends of the conductor. Wire numbers shall be installed before conductors are pulled.

C. Conduit Installation

1. Comply with Section 26 05 33 "Raceway for Electrical Systems," Section 26 05 34 "Boxes for Electrical Systems," for installation.

D. Cable Tray Installation

1. Comply with Section 26 05 36 "Cable Trays for Electrical Systems".

3.3 CONDUIT SCHEDULE

A. Provide conduit and type per below

1. Power wiring > 24V – Conduit type per locations below
2. Thermostat / sensor rough-in – EMT conduit
3. Below 8' AFF in unfinished spaces – EMT conduit
4. Exposed to view in finished spaces – EMT conduit to be painted to match
5. Connection to rotating equipment – jacketed flexible liquid tight (sealtite)
6. Exterior above grade – Aluminum rigid conduit
7. Exterior below grade – electrical PVC
8. All in _____ space

B. Open wiring permitted with J-hook supports, maximum spacing 6 feet, for the following applications:

1. Above lay-in ceilings
2. Above 8' AFF in unfinished spaces, unless noted otherwise.
3. Bridal rings can be used when supporting a maximum of 6 wires.

END OF SECTION 25 50 00

SECTION 26 05 13 – MEDIUM VOLTAGE CABLE, TERMINATIONS, AND SPLICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cables
 - 2. Terminations
 - 3. Splices and splice kits
 - 4. Separable insulated connectors

1.2 ACTION SUBMITTALS

- A. Product Data
- B. Samples: 16” samples for each type of medium voltage cable specified including jacket markings.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturers installation instructions
- B. Installer certifications
- C. Factory Cable Test Results for each cable provided.
- D. Coordination Drawings: Show location of each cable, splice and termination.

1.4 CLOSEOUT SUBMITTALS

- A. Post-installation Hi-pot test results

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Cables

1. Prysmian
2. Southwire
3. Okonite
4. Superior Essex
5. General Cable Co.

B. Splices and Terminations

1. 3M
2. Eaton Cooper Power Systems
3. Elastimold
4. Hubbell
5. Raychem

C. Separable Insulated Connectors

1. 3M
2. Eaton Cooper Power Systems
3. Elastimold
4. Hubbell
5. Raychem

2.3 CABLES

- A. Shielded cable shall be Type MV 105 rated 15KV 105°C with a single compact Class B stranded copper conductor. The construction shall include an extruded conductor shield, EPR insulation rated 133%, a wrapped helically overlapped copper tape shield and a PVC jacket. Cable shall be furnished in sizes as shown on the drawings.

2.4 SPLICES, TERMINATIONS, SEPARABLE INSULATED CONNECTORS

- A. 5/15/35KV splices for shielded single conductor cables shall be 3M Series 5500. A 3M C1 series connector must be used for conductor sizes #2 – 250MCM. 5/15/35KV terminations shall be 3M Series 7600. Connectors for splices and lugs for terminations shall be compatible with the cable and terminal, compression type rated for 5000/15000/35000 volts and installed per manufacturer's requirements.
- B. 5KV splices for unshielded single conductor cables shall be 3M Series 5740. A 3M C1 series connector must be used for conductor sizes #2 – 250MCM. 5KV terminations shall be 3M Series 5610A. Connectors for splices and lugs for terminations shall be compatible with the cable and terminal, compression type rated for 5000 volts and installed per manufacturer's requirements.
- C. Provide 200A load break elbows as indicated on the drawings for cable terminations. Elbows shall be equipped with test ports.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Furnish and install a 5KV distribution system, including manholes, conduits, cables, splices, terminations, concrete ductbanks, trenching and backfill as indicated on the drawings.
- B. The minimum cable bending radius required by the NEC and the cable manufacturer shall be maintained. In cases where the two differ, a minimum of 12 times the outside cable diameter shall be used, or the larger bending radius shall be used, whichever is larger. Cable installation into or out of manholes shall be done using a Heavy-Duty Quadrant Block, similar to a Condux International Catalog No. 08539100 (six 4" sheaves on a 24" radius). A minimum bending radius of 16 inches shall be maintained.
 - 1. Bending cables to less than the minimum radius shall be a reason for not accepting the cable.
- C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - 1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
 - 2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
 - 3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
 - 4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.
- D. All junction and pull boxes shall be sized in accordance with National Electric Code requirements.
- E. Medium voltage splices and terminations shall be installed where indicated on the drawings or as approved by the Owner's Representative.
- F. Cable splices shall be installed per manufacturer's recommendations including proper arrangement and preparation. Manufacturer should be contacted for any necessary installation restrictions and training.
- G. Ground shields of shielded cables at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connection fittings, and hardware.
- H. Ground shields of shielded cable at one point only. Maintain shield continuity and connections to metal connection hardware at all connection points.

3.2 FIELD QUALITY CONTROL

- A. Test the insulation values of all cables, terminations, and splices using a D.C. High Potential Test in accordance with ICEA S-68-516/NEMA WC-8. A controlled voltage source shall be used between the test equipment and power source. Testing shall reach a voltage of 25/65/124kV

(5/15/35kV operating) and be held there for 15 minutes. Engineer or Owner's Representative shall be present to witness all tests. Submit a record of test results and plotted curves.

- B. Medium-voltage cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 26 05 13

SECTION 26 05 19 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Copper building wire rated 600V or less
 - 2. Aluminum building wire rated 600V or less
 - 3. Type MC metal-clad cable rated 600V or less
- B. Reference Sections:
 - 1. Division 26 Section "Identification for Electrical Systems"
 - 2. Division 26 Section "Hangers and Supports for Electrical Systems"
 - 3. Division 27 Section "Communications Optical Fiber Backbone Cabling"
 - 4. Division 27 Section "Communications Copper Horizontal Cabling Systems"
 - 5. Division 27 Section "Communications Coaxial Horizontal Cabling Systems"
 - 6.

1.2 ACTION SUBMITTALS

- A. Product data.

1.3 INFORMATIONAL SUBMITTALS

- A. Not required.

1.4 CLOSEOUT SUBMITTALS

- A. Not required.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. Comply with NFPA 70.

2.2 CONDUCTORS AND CABLES

- A. Available Manufacturers: Subject to compliance with requirements, provide materials by one of the following:
 - 1. Southwire Company
 - 2. Encore Wiring
 - 3. Nexans
 - 4. United Copper Industries
 - 5.
- B. [Aluminum] [and] [Copper] conductors and insulation shall comply with NEMA WC 70.
- C. Acceptable multi-conductor cable types shall comply with NEMA WC 70:
 - 1. Type AC, armored cable
 - 2. Type HCF, metal clad cable, with green ground for normal power circuits
 - 3. Type MI, mineral insulated, metal-sheathed cable
 - 4. Type USE with ground wire
 - 5. Type SO
 - 6. Type MC, metal clad cable, with ground wire
- D. Cable types AC-AP and BX/AC are not permitted. (would hesitate keeping this in; if cable type is not listed in C, then it is not permitted).

2.3 CONNECTORS AND SPLICES

- 1. Available manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFC Cable Systems, Inc.
 - b. Hubbell Power Systems, Inc.
 - c. O-Z/Gedney; EGS Electrical Group LLC
 - d. 3M, Electrical Products Division
 - e. Tyco Electronics Corp.
- 2. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.4 PROVISIONS FOR WIRING:

- A. Wire and cable of the sizes and types shown on the plans and/or hereinafter specified shall be furnished and installed by the Contractor.
- B. All wire and cable shall be new soft drawn copper and shall conform to all the latest requirements of the National Electrical Code IPCEA, and meet the specifications of the ASTM.

2.5 CONTROL CONDUCTORS: Control circuit wiring shall be No. 12 AWG or smaller stranded wire. Stranded control wire shall be provided with crimp type spade terminators. Control circuit wiring shall be color-coded or numbered using an identical number on both ends of the conductor.

See Division 26 Section "Identification for Electrical Systems" and Division XX "XXXX" for more information.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATION

- A. No wire less than No. 12AWG shall be used except for control circuits or low voltage wiring.
- B. Feeders: [Copper stranded for feeders smaller than No. 4AWG; copper or aluminum for feeders No. 4AWG and larger] [Copper solid for No. 10AWG and smaller; stranded for No. 8AWG and larger]
- C. Branch Circuits: [Copper, stranded] [Copper solid for #10 AWG and smaller; stranded for #8 AWG and larger]
- D. Voltage Drop: Branch circuits shall be sized for maximum voltage drop of 3 percent per ASHRAE Standard 90.1. The following are minimum allowable conductor sizes based on conductor length. Circuit length is measured as from the panelboard to the furthest device on the circuit. The phase and neutral conductors shall be sized as indicated for the entire length of the circuit unless a larger size is noted on the drawings.
 - 1. 20A Branch Circuit Homeruns shall be sized as follows:
 - a. 120V:
 - 1) 0 – 95 feet shall be #12AWG wire minimum
 - 2) 96 – 150 feet shall be #10AWG wire minimum
 - 3) 151 – 235 feet shall be #8AWG wire minimum
 - 4) 236 – 380 feet shall be #6 AWG wire minimum
 - b. 277V:
 - 1) 0 – 200 feet shall be #12AWG wire minimum
 - 2) 201 – 350 feet shall be #10AWG wire minimum
 - 3) 351 – 550 feet shall be #8AWG wire minimum
- E. Where conductors are upsized to account for deratings or voltage drop and are too large for the termination lugs, provide reducer pins equivalent to Burndy AYP or AYPO (offset pin). Reducer pins shall be compression type, dual rated for aluminum/copper conductors, and include an insulating cover.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS

- A. All conductors shall have insulation rated for 600V and 90°C
- B. Fire Pump Service Entrance: [Type XHHW, single conductors in raceway] [Mineral-insulated, metal-sheathed cable, Type MI]

- C. Feeders: Type THHN & THWN-2, single conductors in raceway unless shown or specified to be otherwise.
- D. Branch Circuits: [Type THHN & THWN-2, single conductors in raceway] [Armored cable, Type AC] [Metal-clad cable, Type HCF with green ground conductor for normal power circuit].
- E. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh and strain relief devices to suit application.
- F. Class 1 Control Circuits: Type THHN-THWN-2, in raceway.
- G. Class 2 Control Circuits: Type THHN-THWN-2, in raceway.

3.3 INSTALLATION

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems." (where is cable support covered?)
- F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."
- G. A single raceway shall be limited to a maximum of six current carrying conductors.
- H. All 120V and 277V single phase circuits require a dedicated neutral conductor. The neutral conductor shall be numbered and identified with associated phase conductor at the panelboard as well as all junction boxes.(move to Identification)
- I. Where circuit runs are combined, upsize conduit and conductors to accommodate for conduit fill and conductor derating respectively.
- J. Metal Clad (MC) Cable:
 - 1. Permitted for wiring the final portion of light fixture branch circuits. Fixture whips shall be limited to 6 feet maximum. The MC cable may be supported by the light fixture bracing wires but shall not be supported by the ceiling grid support wires.
 - 2. Shall not be installed where exposed.
- K. Health Care Facility (HCF) Cable:

1. Permitted to be used as part of normal power branch circuit wiring.
2. May be used in existing to remain walls to feed new devices.
3. For new construction, normal power branch circuits shall be hard piped to a junction box within individual spaces served. HCF cable may then be used to extend branch circuits to normal power devices within the space.
4. Shall not be installed as branch circuit home run.
5. Shall not be installed where exposed.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 1. After installing conductors and cables and before electrical circuitry has been energized, test feeder conductors for compliance with requirements.
 - a. Megger test for insulation integrity.
 - b. Test all branch circuit wiring for leakage current requirements for NFPA 99 for isolation panelboard.
 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 3. Infrared scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
 - a. Follow-up infrared scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

- c. Record of infrared scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- C. 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.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 19

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding hubs.
5. Grounding and bonding connectors.
6. Intersystem bonding bridge grounding connector.
7. Grounding and bonding busbars.
8. Signal reference grids.
9. Grounding (earthing) electrodes.
10. Grounding electrode enclosures.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" specifies seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 264113 "Lightning Protection for Structures" specifies bonding of lightning protection grounding electrodes to facility grounding electrodes.
4. Section 270528 "Pathways for Communications Systems" specifies additional requirements for grounding and bonding of communications raceways, boxes, and cable trays.
5. Section 271100 "Communications Equipment Room Fittings" specifies additional requirements for grounding and bonding of communications equipment.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Plans showing dimensioned locations of grounding features described in "Field Quality Control for Grounding and Bonding of Electrical Power" Article, including the following:

1. Grounding electrode access enclosures.
2. Grounding electrodes.

- C. Field quality-control reports.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:

- 1. In addition to items specified in Section 260010 "Supplemental Requirements for Electrical," include the following:
 - a. Photographs of transformer grounding.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

- A. Equipment Grounding Conductor:

- 1. General Characteristics: 600 V, THHN/THWN-2 wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

- B. ASTM - Bare Copper Grounding and Bonding Conductor:

- 1. Referenced Standards: Complying with one or more of the following:
 - a. Soft or Annealed Copper Wire: ASTM B3.
 - b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
 - c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
 - d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

2.2 CONNECTORS:

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure (clamp) type with at least two bolts.
- C. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Pressure Connectors: High-conductivity-plated units.
- E. Bolted Clamps: Heavy-duty units listed for the application.
- F. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

- G. Compression Connectors: Irreversible compression connectors must be factory filled with oxide inhibitor and fully crimped with a 14-ton or larger hydraulic tool so that index number is embossed on the connector. May be used above or below grade.
- H. Lightning Protection Aluminum-To-Copper Connections: Bimetallic type, conforming to UL 96, "Lightning Protection Components," or UL 467.

2.3 GROUNDING AND BONDING BUSBARS

- A. Description: Miscellaneous grounding and bonding devices that serve as common connection for multiple grounding and bonding conductors.
- B. Predrilled rectangular bars of annealed copper, 1/4-inch by 6 inches in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.4 GROUNDING ELECTRODE ENCLOSURES

- A. Description: Enclosures designed to protect grounding electrodes from damage while providing access for inspection and testing of the grounding system.
- B. Ground Rods: Copper-clad steel.
 - 1. Size: 3/4 inch diameter by 10 feet length.
- C. Test Wells: Provide handholes as required.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.
- B. Inspect test results of grounding system measured at point of electrical service equipment connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS

- A. Grounding and Bonding Conductors:

1. Provide solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.
2. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
3. Underground Grounding Conductors: Install bare copper conductor, 4/0 AWG minimum.

B. Grounding and Bonding Connectors:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

C. Grounding and Bonding Busbars: Provide in electrical equipment rooms, telecommunication rooms, in rooms housing service equipment, and elsewhere as indicated on Drawings.

3.3 SELECTION OF GROUNDING AND BONDING PRODUCTS FOR COMMUNICATIONS

- A. Comply with Section 270528 "Pathways for Communications Systems" and Section 271100 "Communications Equipment Room Fittings."

3.4 INSTALLATION OF GROUNDING AND BONDING

- A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Grounding and Bonding Conductors:

- a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- b. Underground Grounding Conductors:
 - 1) Bury at least 30 inch (750 mm) below grade.
 - 2) Duct-Bank Grounding Conductor: Bury 12 inch (300 mm) above duct bank when indicated as part of duct-bank installation.

2. Grounding and Bonding Connectors: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

- a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 - b. Make connections with clean, bare metal at points of contact.
 - c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
 - d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 - e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 - f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
 - 2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.
 - g. Grounding and Bonding for Piping:
 - 1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
 - 3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
 - h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
 - i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft (18 m) apart.
3. Grounding and Bonding Busbars:
- a. Install busbar horizontally, on insulated spacers 2 inch (50 mm) minimum from wall, 6 inch (150 mm) above finished floor unless otherwise indicated.
 - b. Where busbars are indicated on both sides of doorways, route bonding conductor up to top of door frame, across top of doorway, and down; connect to continuation of horizontal busbar.
4. Electrodes:

- a. Ground Rods: Drive rods until tops are 2 inch (50 mm) below finished floor or final grade unless otherwise indicated.
 - 1) Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2) Use exothermic welds for below-grade connections.
 - b. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to service grounding electrode conductor.
 - c. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and must be at least 12 inch (300 mm) deep, with cover.
 - 1) Install at least one test well for each service unless otherwise indicated. Install at ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
 - d. Concrete-Encased Electrode (Ufer Ground):
 - 1) Fabricate in accordance with NFPA 70; use minimum of 20 ft (6 m) of bare copper conductor not smaller than 4 AWG.
 - a) If concrete foundation is less than 20 ft (6 m) long, coil excess conductor within base of foundation.
 - b) Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
 - 2) Fabricate in accordance with NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 ft (6.0 m) long. If reinforcing is in multiple pieces, connect together by usual steel tie wires or exothermic welding to create required length.
5. Grounding at Service:
- a. Equipment grounding conductors and grounding electrode conductors must be connected to ground busbar. Install main bonding jumper between neutral and ground buses.
6. Grounding Underground Distribution System Components:
- a. Duct-Bank Grounding Conductor: Bury 12 inch (300 mm) above duct bank when indicated as part of duct-bank installation.
 - b. Comply with IEEE C2 grounding requirements.
 - c. Grounding Manholes and Handholes: Install driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inch (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide 1/0 AWG bare, tinned-copper conductor from ground rod into manhole

through waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inch (50 mm) above to 6 inch (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

- d. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields in accordance with manufacturer's published instructions with splicing and termination kits.
- e. Pad-Mounted Transformers and Switches: Install two ground rods and ring electrode around pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than 2 AWG for ring electrode and for taps to equipment grounding terminals. Bury ring electrode not less than 6 inch (150 mm) from foundation.

7. Equipment Grounding and Bonding:

- a. Install insulated equipment grounding conductors with feeders and branch circuits.
- b. Install insulated equipment grounding conductors with 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) Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- c. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- d. Poles Supporting Outdoor Lighting Fixtures: Bond insulated equipment grounding conductor to equipment grounding terminal inside pole base.
- e. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground fence and bond fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.5 FIELD QUALITY CONTROL FOR GROUNDING AND BONDING

- A. Field tests and inspections must be witnessed by Owner.
- B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
 - c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

C. Nonconforming Work:

1. Grounding system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective components and retest.

D. Collect, assemble, and submit test and inspection reports.

1. Report measured ground resistances that exceed the following values:
 - a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 Ω
 - b. Substations and Pad-Mounted Equipment: 5 Ω .
 - c. Manhole Grounds: 10 Ω .

3.6 PROTECTION

- A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260526

SECTION 26 05 33 – RACEWAY FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Electrical metallic tubing conduit (EMT)
 - 2. Galvanized rigid steel conduit (GRS)
 - 3. Rigid aluminum conduit
 - 4. Polyvinyl chloride conduit (PVC)
 - 5. Liquid-tight flexible metal conduit
 - 6. Flexible metal conduit
 - 7. High density polyethylene conduit (HDPE)
 - 8. PVC coated galvanized rigid conduit
 - 9. Surface raceway
 - 10. Pre-wired raceway

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Surface mounted raceway
 - 2. Pre-wired raceway
- B. Shop Drawings:
 - 1. Pre-wired raceway

1.3 INFORMATIONAL SUBMITTALS

- A. Not required

1.4 CLOSEOUT SUBMITTALS

- A. Not required

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. Product shall be UL approved.
- C. Comply with NFPA 70.

- D. Comply with ANSI C2.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available manufacturers: Subject to compliance with requirements, provide product by one of the following:
1. AFC Cable Systems, Inc.
 2. Alflec Inc., a unit of Southwire.
 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 5. Electri-Flex Co.
 6. Republic Conduit, a unit of Tenaris.
 7. Western Tube and Conduit Corporation.
 8. Wheatland Tube Company.
- B. Surface mounted and pre-wired raceway
1. Wiremold
 2. Panduit
 3. Hubbell
 4. MonoSystems

2.2 ELECTRICAL METALLIC TUBE CONDUIT (EMT)

- A. EMT conduit shall be installed for all work concealed in partitions or in concrete block walls and for all conduits run in ceiling plenums and exposed runs, except where noted otherwise. Aluminum EMT is not approved. [EMT conduit shall not be used outdoors, in wet locations, in floor crawl spaces, or below 5' AFF.]
- B. EMT couplings and connectors shall be steel [or diecast], set screw or compression type.

2.3 GALVANIZED RIGID STEEL CONDUIT (GRS)

- A. Galvanized rigid steel conduits shall be installed for all exposed outdoor conduit, and for all indoor medium voltage cable runs, [and for entry into underground building walls and manholes].
- B. All GRS couplings and threaded hubs shall have no less than five threads of the coupling engaged. Running threads shall not be used. All GRS conduits shall be reamed.
- C. All GRS conduits shall have two locknuts and a bushing at each termination outlet box, junction box, etc., except where terminated in a threaded hub.
- D. GRS conduit shall be installed where underground conduits and duct banks enter through building foundation, tunnel walls, and drilled holes in manhole walls. The heavy wall conduit shall enter through core drilled holes and the annular space between the conduit and wall sealed using

Thunderline Corp. "Link-Seal" Catalog No. 10-LS-300-C seals. This catalog number is for a 4 inch heavy wall steel conduit and requires a 6 inch I.D. core drilled hole. Refer to the manufacturer's installation requirements prior to drilling holes and for other conduit sizes. Seals as manufactured by Innerlynx Model C and Flexicraft Type E are acceptable equivalents.

2.4 RIGID ALUMINUM CONDUIT

- A. Rigid aluminum conduits shall be installed for all exterior conduits supplying cooling towers [and MRI exam rooms].

2.5 POLYVINYL CHLORIDE CONDUIT (PVC)

- A. Conduits installed underground shall be schedule 40 PVC and a minimum size of 3/4" trade size. PVC conduits may be installed in concrete floor slabs, and shall be a minimum of 3/4" trade size. Rigid galvanized steel elbows shall be used for all stub-ups through or out of concrete slabs or through underground wall penetrations.
- B. All PVC fittings shall be connected with PVC primer and glue.

2.6 LIQUID-TIGHT FLEXIBLE METAL CONDUIT

- A. Liquid-tight flexible steel conduit ('Sealtite') shall be used in wet areas where flexible conduit connections are required and on all motorized equipment and motors in all locations.
- B. Liquid-tight flexible metal conduit ('Sealtite') is not permitted for roof penetrations.

2.7 FLEXIBLE METAL CONDUIT

- A. Flexible steel conduit ('Greenfield') shall be used where vibration isolation is required, including all transformers and uninterruptible power systems.

2.8 HIGH DENSITY POLYETHYLENE CONDUIT (HDPE)

- A. Type HDPE Schedule 40 conduit may be used for site lighting conduits.
- B. Type HDPE Schedule 40 to be used for all directional boring applications. Provide UL listed coupling fitting where transitioning from HDPE to PVC/GRC.

2.9 PVC COATED GALVANIZED RIGID STEEL CONDUIT

- A. PVC coated galvanized rigid steel conduits shall be installed for all exposed outdoor conduit.
- B. All PVC coated GRS couplings and threaded hubs shall have no less than five threads of the coupling engaged. Running threads shall not be used. All PVC coated GRS conduits shall be reamed.

- C. All PVC coated GRS conduits shall have two locknuts and a bushing at each termination outlet box, junction box, etc., except where terminated in a threaded hub.
- D. Patch all damaged areas of coating protection upon completion of installation.

2.10 SURFACE MOUNTED RACEWAY

A. General Requirements

- 1. Surface mounted raceway shall be as manufactured by Wiremold, Panduit, Hubbell, or Monosystems. Part numbers listed in these specifications or the drawings refer to Wiremold products unless noted otherwise.
- 2. Furnish raceways with all elbows, fittings, boxes, clips, supports and accessories for a complete installation.
- 3. All field modifications to surface mounted raceway shall be made using the manufacturer's cutting tool with shearing action, maintaining clean joints, free from all burrs.
- 4. Furnish and install dividers in all raceways for which dividers are an option.

B. Small Raceway

- 1. Raceway shall be V500/V700 Series, V700 shall be used in all areas where V500 fill is exceeded, unless otherwise noted.
- 2. Raceway shall be steel. non-metallic
- 3. Raceway shall be ivory. white.
- 4. Raceway shall be painted to match wall color.
- 5. Raceway shall be used to route cabling and branch circuiting on existing walls in finished spaces where conduit and wiring cannot be concealed, unless noted otherwise. In mechanical, electrical, and data rooms conduit shall be used in lieu of surface mounted raceway. Refer to this specification section for all conduit requirements.

C. Prewired Raceway, Single Cell

- 1. Where indicated on the drawings the Contractor shall furnish and install single cell raceway factory prewired, for power or precut punched data covers with device spacing and wiring as indicated on the drawings.
- 2. Raceway shall be steel- Series 3000. aluminum- Series AL3000.
- 3. The raceway shall be furnished with covers in 12" lengths.
- 4. Refer to specification section 26 27 26 for wiring device requirements. If applicable, provide standard single gang opening for low voltage device faceplates. Contractor shall install low voltage wiring and terminate cables as required by Division 27. All accessories shall be provided with the raceway to accommodate low voltage cable install.
- 5. Custom, project specific shop drawings shall be submitted for review prior to rough-in.

D. Prewired Raceway, Two-Cell

- 1. Where indicated on the drawings the Contractor shall furnish and install two-cell raceway factory prewired, for power and precut punched data covers with device spacing and wiring as indicated on the drawings.
- 2. Raceway shall be aluminum- Series AL4000. stainless steel- Series S4000.
- 3. The raceway shall be furnished with covers in 12" lengths.
- 4. Refer to specification section 26 27 26 for wiring device requirements. Provide standard single gang opening for low voltage device faceplates. Contractor shall install low voltage wiring and terminate cables as required by Division 27. All accessories shall be provided with the raceway to accommodate low voltage cable install.

5. Custom, project specific shop drawings shall be submitted for review prior to rough-in.
- E. Prewired Raceway, Three-Cell
1. Where indicated on the drawings the Contractor shall furnish and install three-cell raceway factory prewired, for power and precut punched data covers with device spacing and wiring as indicated on the drawings.
 2. Raceway shall be aluminum- Series AL7320.
 3. The raceway shall be furnished with covers in 12" lengths.
 4. Refer to specification section 26 27 26 for wiring device requirements. Provide standard single gang opening for low voltage device faceplates. Contractor shall install low voltage wiring and terminate cables as required by Division 27. All accessories shall be provided with the raceway to accommodate low voltage cable install.
 5. Custom, project specific shop drawings shall be submitted for review prior to rough-in.
- F. Prewired Designer Raceway, Two-Cell
1. Where indicated on the drawings the Contractor shall furnish and install two-cell designer style raceway factory prewired, for power and precut punched data covers with device spacing and wiring as indicated on the drawings.
 2. Raceway shall be aluminum- Series ALDS4000.
 3. The raceway shall be furnished with covers in 12" lengths.
 4. Devices shall be mounted in an upward-facing activation configuration where mounted above countertop backsplashes, all other locations shall be mounted in a downward-facing activation.
 5. Refer to specification section 26 27 26 for wiring device requirements. Contractor shall install low voltage wiring and terminate cables as required by Division 27. All accessories shall be provided with the raceway to accommodate low voltage cable install.
 6. Custom, project specific shop drawings shall be submitted for review prior to rough-in.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Minimum conduit size shall be $\frac{3}{4}$ " trade size for branch circuits.
- B. A bushing shall be used where conduit enters a panel box or equipment enclosure.
- C. Grounding Bushings shall be used to bond conduits entering a panel box or equipment that are not mechanically connected.
- D. All raceways for equipment and devices located within or on the building are to be routed through the interior of the building. Do not route conduits on the roof, surface mounted on the building exterior walls or via exterior trenches or directional bores between areas of the building, unless noted otherwise or prior approval is provided by the Architect/Engineer. (Engineer note: Per NEC 300.7(B), expansion fitting is required for raceways exposed to different temperatures.)
- E. Expansion fittings shall be provided at all conduits across building expansion joints. Fittings shall be Type "AX" or "TX" as made by O Z Electric Company, or approved equal. Provide copper bonding jumper at each expansion fitting.

- F. Conduit bends shall be made with standard benders of proper size; radius of bends to be at least 6 times the diameter of the conduit. Runs between outlets shall not contain more than the equivalent of three 90-degree bends. Conduit runs shall be continuous from outlet to outlet, outlet to cabinet, etc.
- G. All exposed conduits shall be installed parallel or perpendicular to the building walls or floors.
- H. Conduits shall be securely fastened to or supported from the building structure. Conduits not fastened directly to building structure shall be supported by a rigid assembly, free of sway and adequately braced, connected directly to the building structure. The use of 'pencil' wire, ceiling wire, and cable hangers shall not be permitted.
- I. Anchor or stake down all direct burial conduits to prevent shifting during grading and concrete pours. Spacers shall be provided for trenches with 2 or more conduits with any conduit 2" or larger.
- J. Install #12AWG pull wires for tracing for all underground non-metallic empty conduits with a minimum of 12 inches of slack on each end. Pull strings shall be used for empty above grade or metallic conduits.
- K. All raceways installed within 1½" of the roof deck shall be GRS or IMC. Boxes shall be offset below the 1½".
- L. [Conduits installed horizontally in finished spaces without ceilings shall be installed above the roof deck. These spaces include gymnasium, multi purpose rooms and natatoriums. Conduit type for this application to be GRS or IMC in accordance with Article 300.4 of the National Electrical Code. Vertical drops from the roof deck shall be EMT and be routed along and attached to the structural steel.]
- M. All exposed raceways installed in a finished space will be painted to match the background, unless noted otherwise. Finished spaces include all areas open to the general public. Spaces such as storage, mechanical, IT, and electrical rooms and other similar areas only accessible to qualified personnel are considered unfinished.
- N. All penetrations through not rated walls shall be sealed for draft stopping with caulk, putty, etc. designed for this use.
- O. Fire / Smoke seals: (EDITOR'S NOTE: Fire seals are required on a project, include this section on the cover sheet).
 - 1. All penetrations through fire rated walls and floors shall be fire sealed in accordance with ASTM E814/UL1479 or manufacturer's recommendations.
 - 2. Materials and installation details shall be submitted for approval.

END OF SECTION 26 05 33

SECTION 26 05 34 – BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pull boxes
 - 2. Junction boxes
 - 3. Outlet boxes
 - 4. Outdoor boxes
 - 5. Handholes
 - 6. Manholes
 - 7. Floor boxes
 - 8. Poke-through boxes

1.2 ACTION SUBMITTALS

- A. Product Data including all accessories, parts, and components required for a complete installation:
 - 1. Outdoor boxes
 - 2. Handholes
 - 3. Manholes
 - 4. Floor boxes
 - 5. Poke-through boxes
- B. Shop drawings:
 - 1. Manholes

1.3 INFORMATIONAL SUBMITTALS

- A. Not required

1.4 CLOSEOUT SUBMITTALS

- A. Not required

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 OUTLET BOXES, JUNCTION BOXES, FITTINGS

- A. Pull boxes and junction boxes shall be installed where indicated on the drawings or where required to facilitate wire installation.
 - 1. Size: Outlet, junction, and pull boxes not dimensioned shall be 4-inch square by 2-1/8" deep minimum and comply with sizing as required by Article 314 of the National Electrical Code.
- B. Steel faceplates must be used on fire rated drywall walls and painted to match device color. Faceplates shall be Mulberry Metal Products or equivalent.
- C. All outdoor junction boxes and conduits shall be gasketed.
- D. Handholes shall be installed where indicated on the drawings or where required to facilitate wire installation.
 - 1. Handholes not dimensioned shall be 12 inch by 12 inch by 12" deep minimum with open bottom and comply with sizing as required by Article 314 of the National Electrical Code. Handhole to be gasketed. Install on a minimum 6" gravel base with top of handhole flush with grade. Manufactured by Quazite or equivalent.
 - 2. Bolted style cover with gasket to match handhole. Include with "Electric" logo, unless noted otherwise.
 - 3. Handhole and handhole cover to be rated as Tier 15 loading.
- E. Manholes shall be installed where indicated on the drawings.
 - 1. Manholes to be precast concrete and rated for H-20 structural load rating (medium duty)
 - 2. Manholes to be 6'-0" x 12'-0" x 8'-0" deep with 36" opening, unless noted otherwise.
 - 3. Cover to be solid, constructed of cast iron. Include with "Electric" logo, unless noted otherwise.
 - 4. Manhole accessories to include galvanized cabling racking and pulling irons on all four sides, sump pump pit and hook ladder.

2.3 FLOORBOXES AND POKE-THRU DEVICES

- A. Furnish and install floorboxes and poke-thru devices as specified on the drawings. Equivalent products by manufacturers other than that shown on the drawings are acceptable unless noted otherwise.
- B. Provide all accessories required for a complete installation.
- C. Provide blank fillers or plates to cover all unused openings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mounting:
 - 1. Outlets must be centered with regard to paneling, furring, trim, etc.

2. Outlets shall be set plumb or horizontal and shall extend to finished surface of wall, ceiling, or floor without projecting beyond or behind finished surface.
 3. Outlet boxes shall not be installed "back-to-back". Provide at least 6 inch of separation or greater where required by the building code.
 4. Electrical devices installed on Fire/Smoke partitions shall be installed with a 16 inch maximum opening on one side only in each framing space. All clearances between such devices and the gypsum board shall be completely filled with joint compound or other UL approved materials.
 5. In fire rated drywall walls, 24" spacing must be maintained between boxes on opposite sides of walls. Moldable fire protective putty pads, firestopping coverplate gaskets, internal fire rated pads or other acceptable fire sealing means shall be installed on outlet boxes where the 24" spacing cannot be maintained.
 6. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall
 7. Set metal floor boxes level and flush with finished floor surface.
 8. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
 9. Finish plates shall not span different types of wall finishes either vertically or horizontally. Plates shall cover mortar joints and cut openings completely.
 10. Outlet, junction and pull boxes, and their covers shall have corrosion protection suitable for the atmosphere in which they are installed. Provide gaskets for all boxes installed outside and other wet or damp locations (tunnels, crawl spaces, pits, etc.).
 11. Outlet boxes shall be protected to prevent entrance of plaster, and debris shall be thoroughly cleaned from the box prior to installation of conductors.
 12. Single gang opening outlet boxes shall be mounted with the long axis vertical unless otherwise noted for horizontal mounting. Three or more gang boxes shall be mounted with the long axis horizontal.
 13. Finish plates shall be a type designed, intended, and appropriate for the use and location.
 14. Existing outlet boxes are being reused, provide extension rings compatible with new wall surfaces or finishes.
 15. Radiology/Imaging areas where lead shielding is required behind outlet boxes, Contractor shall provide such shielding.
 16. Provide outlet box with barrier for grouped or ganged light switched where voltage between adjacent switches exceeds 300 volt AC per NEC Article 380.
 17. Provide outlet box with barrier and separate conduit feed for switches grouped or ganged where connected to utility power and standby power.
 - 18.
- B. Attaching: Boxes shall be attached by fastener designed for the purpose and shall provide adequate mechanical strength for future maintenance.
1. Boxes installed in metal stud partitions shall be secured to the metal studs using appropriate clips, fasteners, hangers, or supports as required, and shall provide adequate far side box support to fulfill the intent of all applicable codes.
- C. Firestopping: Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Firestopping"

END OF SECTION 26 05 34

SECTION 26 05 36 – CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wire basket cable tray
 - 2. Center hung cable tray
 - 3. Ladder type cable tray
- B. Furnish and install cable tray with all required accessories for a complete installation

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: To include Manufacturer's layout drawings in [PDF] [CAD Dwg] format.
- C. Seismic Restraint Design:
 - 1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer who is licensed in the state where Project is located and who is responsible for their preparation.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.3 INFORMATIONAL SUBMITTALS

- A. Installation instructions: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Not required

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Wire Basket
 - 1. B-Line Flextray
 - 2. Hubbell Wire Basket Tray System
 - 3. Cablofil Wire Basket Tray
 - 4. MonoSystems Mono-Mesh
- B. Center Hung
 - 1. Wiremold
 - 2. MonoSystems
- C. Ladder Type
 - 1. B-Line

2.3 WIRE BASKET CABLE TRAY

- A. Cable tray shall be [electro-plated zinc] [stainless steel] [pre-galvanized steel][powder coated finish color per Owner], sized as indicated on the drawings.
- B. Furnish cable tray with all required accessories for a complete installation.
- C. Supports shall be wall brackets or center hangers as indicated on the drawings. Adequate bracing shall be provided to prevent twisting of the tray when loaded.
- D. Wire basket cable tray shall have a 4 inch usable loading depth by 12 inches wide.

2.4 CENTER HUNG CABLE TRAY

- A. Cable tray shall be aluminum, center hung, and suspended above ceilings where shown on the drawings. Adequate bracing shall be provided to prevent twisting of the tray when loaded.
- B. Cable tray shall be as indicated on the drawings, but not less than 12" wide with 3" loading depth or more than 12" rung spacing.
- C. Cable tray shall be NEMA Loading Class 12A (50 lbs/ft.)
- D. Furnish with all required accessories.

2.5 LADDER TYPE CABLE TRAY

- A. Cable tray shall be stainless steel] 6" siderail, ladder-type with 12" rung spacing
- B. Cable tray widths shall be as indicated on drawings.
- C. Cable tray fittings shall have a minimum of 36" radius.

- D. Supports shall be wall brackets or trapeze type [of non-ferrous material]. Spacing per Manufacturer's requirements.
- E. Cable tray shall be capable of carrying a uniformly distributed load of 100 lbs./ft. on a 12 foot support span with a safety factor of 1.5 when supported as a simple span and tested per NEMA VE1 Section 5.2.
- F. Furnish with all required accessories for a complete installation. Include expansion joint splice plates as required where temperature differentials will result in thermal expansion/deflection/contraction. Provide a support within two feet of each side of the expansion joint attached with expansion guides per manufacturer's recommendations that permits linear movement of the tray without lateral deflection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing conditions and adjust location for obstructions.

3.2 INSTALLATION

- A. Cable tray shall be installed in such a manner and with proper parts to maintain an equipment ground path. Bond cable tray where non-continuous. Bond tray to the nearest effectively grounded material.
- B. Conductors shall be securely bound in circuit groups (three phase conductors, neutral, and ground) with cable ties every three feet.

END OF SECTION 26 05 36

SECTION 26 05 48 – SEISMIC RESTRAINT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Seismic restraints for electrical systems

1.2 ACTION SUBMITTALS

- A. Seismic restraint submittals shall be provided for engineer review and include, but not be limited to, detailed drawings showing seismic restraint types, anchor type and attachment details, calculations and spacing requirements of unique equipment and conduit for this specific project. Submittals shall include floor plan drawings indicating equipment, ductwork and piping to be restrained, restraint locations and restraint component types. All submittals and floor plan drawings shall bear the seal of a licensed structural engineer of the State of Missouri [Illinois].

1.3 INFORMATIONAL SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

- A. As-built and field modifications shall be submitted.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. All materials and workmanship shall specifically comply with the above listed Building Code with respect to seismic requirements for the support and anchorage of all electrical, communications and electronic safety and security systems and equipment as installed on this project. Lateral forces to be restrained shall be as required by IBC Section 1621 Architectural, Mechanical, and Electrical Component Seismic Design Requirements and ASCE 7-02 Section 9.6 Architectural, Mechanical, and Electrical Components and Systems with the following design parameters with the design parameters as shown on the drawings:
 - 1. Site Class as Defined in the IBC: Refer to Electrical Cover Sheet

2. In subparagraph below, retain Seismic Use Group or Building Category for Project structure from three classifications defined in the IBC.
 3. Assigned Seismic Use Group or Building Category as Defined in the IBC: Refer to Electrical Cover Sheet
- C. All conduit support and restraint details and practices shall conform to the publication “Seismic Restraint Systems Guidelines” by Cooper B-line-TOLCO.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Submittals shall reflect the actual site conditions as verified by the Contractor.

3.2 INSTALLATION

- A. Install all required seismic restraints per the provided submittals.

END OF SECTION 26 05 48

SECTION 26 05 73 – ARC FLASH HAZARD ANALYSIS, SHORT CIRCUIT ANALYSIS, AND SELECTIVE COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Arc flash hazard analysis
 - 2. Short circuit analysis
 - 3. Selective coordination

1.2 GENERAL INFORMATION

- A. **The contractor shall be responsible for submitting the short circuit, arc flash and selective coordinate study prior to electrical equipment submittals.**
- B. The contractor shall be responsible for revising electrical equipment submittals to accommodate the results of the study, to include breaker changes, AIC rating changes, etc.
- C. Two separate studies shall be provided. One for Craig Hall and one for Art Annex.

1.3 ACTION SUBMITTALS

- A. The results of studies shall be summarized in a preliminary and final report. The preliminary report shall be provided prior to submitted equipment approval. Three (3) bound copies of the complete final report shall be submitted. Electronic PDF copies of the report shall be provided. The report shall include:
 - 1. A One-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.
 - 2. Log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
 - 3. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses.
 - 4. Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, minimum personal-protective equipment AFIE rating and AFIE (Arc Flash Incident Energy) levels.
 - 5. Arc Flash Labels shall be furnished and installed in accordance with NFPA 70E and all applicable local codes and standards.

6. Notify the engineer in writing, of any circuit protective devices improperly rated for the calculated available fault current, of any significant deficiencies in protection and/or coordination and of any significant deficiencies in protection and/or coordination.
- B. The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the device is located, and the device number corresponding to the device on the system one-line diagram.

1.4 INFORMATIONAL SUBMITTALS

- A. Not required.

1.5 CLOSEOUT SUBMITTALS

- A. Not required.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. The contractor shall furnish an Arc Flash Hazard Analysis Study for all new distribution equipment, including but not limited to control panels, starters, disconnects, etc. per the requirements set forth in the current version of NFPA 70E. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584 – 2018.
 1. This study shall include the existing 5kV switchgear.
 2. This study shall include all Craig Hall equipment immediately upstream of the newest distribution equipment.
- B. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer, licensed in the State of Missouri, and skilled in performing and interpreting the power system studies.
- C. The studies shall be performed using the latest version of SKM Systems Analysis PowerTools for Windows (PTW) software program.

PART 3 - EXECUTION

3.1 SHORT CIRCUIT ANALYSIS

- A. Transformer design impedances shall be used when test impedances are not available.

- B. Provide the following:
- a. Calculation methods and assumptions
 - b. Selected base per unit quantities
 - c. One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis. Labeling of components shall match the one-line and floorplans.
 - d. The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions greater than 5HP, and other circuit information as related to the short-circuit calculations.
 - e. Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.
 - f. Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.
- C. For solidly grounded systems, provide a bolted line-to-ground fault current study for applicable buses as determined by the engineer performing the study.

3.2 PROTECTIVE DEVICE COORDINATION ANALYSIS

- A. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.
- B. Include on each TCC graph, a complete title with descriptive device names.
- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
- D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Plot the following characteristics on the TCC graphs, where applicable:
 1. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
 2. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
 3. Transformer full-load current, magnetizing inrush current, inrush/full load current multiplier, and ANSI through-fault protection curves
 4. Medium voltage conductor damage curves
 5. Ground fault protective devices, as applicable
 6. Pertinent motor starting characteristics and motor damage points, where applicable

7. The largest feeder circuit breaker in each motor control center and applicable panelboard.
- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.
- G. Final overcurrent device settings as identified by the protective device coordination study shall be implemented by the installing contractor.

3.3 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in the latest version of NFPA70E, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis and the protective device time-current coordination analysis.
- B. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- C. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.
- D. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations
- E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications.
- F. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.
- G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:
- H. Fault contribution from induction motors should not be considered beyond 5 cycles.

- I. For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment's main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required, and it shall be based on a device located upstream of the equipment to clear the arcing fault.
- J. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
- K. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- L. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

END OF SECTION 26 05 73

SECTION 26 08 00 – COMMISSIONING OF BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to Section 01 91 13 Commissioning of Building Systems for Electrical Contractor responsibilities related to commissioning of mechanical and electrical systems.

END OF SECTION 26 08 00

SECTION 26 09 13 – ELECTRICAL POWER METERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. KWH/Demand meters
 - 2. KWH/Demand meters with real time amps/volts/power factor

1.2 ACTION SUBMITTALS

- A. Product Data

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 KWH/DEMAND METERS

- A. Provide Honeywell E-Mon Class 1000/2000 meter or equivalent.
- B. Meter shall be fully electronic with a 2-line alpha-numeric LCD display without multiplier displaying cumulative kWh and “real-time” kW load. Meter shall provide rate of consumption indication and also a test sequence to ensure integrity of the display.
- C. Option - Meter shall be available with kW/Demand and kW peak date and time displays. (15 minute interval standard, 30 minute interval available.)

- D. Meter shall provide a load indicator to indicate real-time consumption levels for field testing and certification.
- E. Meter shall provide current sensor installation diagnostics indicator.
- F. Meter shall use 0-2 volt output current sensors to allow paralleling and/or mounting up to 2,000 feet from the meter. Sensors shall be of split-core configuration to allow installation without powering down. Sensors shall be available from 100 amp to 3200 amp.
- G. Meter shall be provided for the system phase/voltage required.
- H. Meter shall be enclosed in a heavy-duty JIC steel enclosure suitable for indoor installation. Meter enclosure provides a method of locking to prevent unauthorized access.
- I. Option - Meter shall be provided in an outdoor NEMA 4X polycarbonate enclosure with padlocking hasp & mounting flanges for indoor/outdoor installation.
- J. Meters shall be provided in Honeywell E-Mon MMU (Multiple Meter Configuration) enclosure(s) or equivalent containing up to 24 meters in one compact enclosure when indicated on the drawings.
- K. Meter shall be UL Listed/CUL Listed to latest applicable standards for safety.
- L. Meter shall be certified by a nationally recognized independent test facility to ANSI C12.20 (+/- 0.2% from 1% to 100% of rated load) specifications with split-core current sensors.
- M. Meter shall be provided with a non-volatile memory to maintain reading during power outages.
- N. Meter shall be provided with modular connector(s) to provide interfacing with:
 - 1. AMR (Automatic Meter Reading)
 - 2. Building Management/Energy Management Systems
- O. Meter shall be compatible with Honeywell E-Mon Energy™ software or equivalent.

2.3 KWH/DEMAND METERS WITH REAL TIME AMPS/VOLTS/POWER FACTOR

- A. Provide Honeywell E-Mon Class 5000 meter or equivalent.
- B. Meter shall be fully electronic with a 4-line alpha-numeric LCD display without multiplier displaying cumulative kWh, kW demand (with peak date and time), power factor/amps/volts per phase, and “real-time” kW load. Meter shall provide rate of consumption indication and also a test sequence to ensure integrity of the display.
- C. Option - Meter shall be available with kW/Demand and kW peak date and time displays. (15 minute interval standard, 30 minute interval available.)
- D. Meter shall provide a load indicator to indicate real-time consumption levels for field testing and certification.

- E. Meter shall provide current sensor installation diagnostics indicator.
- F. Meter shall use 0-2 volt output current sensors to allow paralleling and/or mounting up to 500 feet from the meter. Sensors shall be of split-core configuration to allow installation without powering down. Sensors shall be available from 100 amp to 3200 amp.
- G. Meter shall provide current sensor installation diagnostics indicator, phase error indicator and phase angle diagnostics on display.
- H. Meter shall be field programmable for meter date/time, IP address and ID code for communication options.
- I. Meter shall be provided for the system phase/voltage required.
- J. Meter shall be enclosed in a heavy-duty JIC steel enclosure suitable for indoor installation. Meter enclosure provides a method of locking to prevent unauthorized access.
- K. Option - Meter shall be provided in an outdoor NEMA 4X polycarbonate enclosure with padlocking hasp & mounting flanges for indoor/outdoor installation.
- L. Meter shall be UL Listed/CUL Listed to latest applicable standards for safety.
- M. Meter shall be certified by a nationally recognized independent test facility to ANSI C12.20 (+/- 0.2% from 1% to 100% of rated load) specifications with split-core current sensors.
- N. Meter shall be provided with a non-volatile memory to maintain reading during power outages.
- O. Meter shall store interval data for kW and kVAR for up to 72 days in first-in first-out format. Interval data not available via BACnet.
- P. Meter shall operate as slave device when used with Modbus or LonWorks options. Meter works as a master device on BACnet MS/TP.
- Q. Meter shall provide optional 5th & 6th channel for logging inputs from third-party metering devices (gas, water, BTU, etc.) Both channels provide interval data logging that can be read via Honeywell E-Mon Energy software (or equivalent) and Modbus.
- R. Meter shall be capable of daisy-chain connection using RS-485 EZ7 communications for 52 devices. Cabling shall be through RJ-11 modular jack (4-conductor) or terminal block (3-conductor), 22 AWG, up to 4,000 cable feet total.
- S. Meter shall be provided with the following communication protocol & option package:
 - 1. EZ7 (RS-485 Port), EZ7 (Ethernet Port)
 - 2. Modbus RTU (RS-485 Port), EZ7 (Ethernet Port)
 - 3. BACnet MS/TP (RS-485 Port), EZ7 (Ethernet Port)
 - 4. EZ7 (RS-485 Port), Modbus TCP/IP (Ethernet Port)
 - 5. EZ7 (RS-485 Port), BACnet IP (Ethernet Port)
 - 6. Modbus RTU (RS-485 Port), Modbus TCP/IP (Ethernet Port)

PART 3 - EXECUTION

3.1 INSTALLATION

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

END OF SECTION 26 09 13

SECTION 26 09 23 – LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Occupancy sensors
 - 2. Digital countdown timers
 - 3. Dimmers

1.2 ACTION SUBMITTALS

- A. Product Data
- B. Wiring Diagrams

1.3 INFORMATIONAL SUBMITTALS

- A. Not required

1.4 CLOSEOUT SUBMITTALS

- A. Operating Instructions: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 OCCUPANCY SENSORS

- A. Ceiling mounted occupancy sensors shall be dual-technology and white in color unless otherwise noted: Watt Stopper #LMDC-100 or approved equivalent.
 - 1. Sensors shall be programmed in accordance with the lighting control matrix.
- B. Wall mounted occupancy sensors shall be dual-technology and white/ivory in color: Watt Stopper #LMPX-100 or approved equivalent.

1. Sensors shall be programmed in accordance with the lighting control matrix.
- C. Wallswitch occupancy sensors shall be white/ivory in color and be Watt-Stopper #DW-311 or approved equivalent.
 1. Sensors shall be programmed in accordance with the lighting control matrix.
- D. Provide occupancy sensors with relay packs as required or shown on the drawings.
- E. Occupancy sensors shall be programmed to 'manual-on' unless otherwise specified.
- F. Provide open plenum rated wiring in accordance with manufacturer's wiring diagrams.
- G. Rooms or areas with multiple sensors shall be wired so that any sensor activates all lights.
- H. Sensors shall be installed a minimum of 6' from all diffusers.
- I. Refer to wiring diagrams on drawings for additional requirements.

2.3 DIGITAL COUNTDOWN TIMERS

- A. WattStopper TS-400 or approved equivalent.
- B. Countdown Timer to be programmed to the following:
 1. Storage Rooms – 10 minutes with audio and visual options disabled.
 2. Mechanical/Electrical Rooms – 30 minutes with audio and visual options enabled.

2.4 DIMMERS

- A. Provide dimmer switches as shown on drawings. Dimmers will be a combination of wall mounted standalone devices and digital devices that operate by way of a lighting controller. See lighting control matrix for designation where analog vs digital devices are utilized.
- B. Dimmers to be manufactured by WattStopper or approved equivalent.

2.5 LIGHTING CONTROLLERS

- A. Provide lighting controllers as shown on drawings. The plans designate 1, 2, or 3 zone controllers as required for a given space.
- B. Dimming will be primarily 0-10v, though forward phase and/or reverse phase dimming will be utilized at times. See plans for controller designations aligning with the luminaire selection basis of design. Where substitute fixtures are utilized, the EC shall coordinate the variations. See lighting control matrix for designation where standalone vs networked devices are utilized.
- C. Lighting Controllers to be manufactured by WattStopper or approved equivalent.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SENSORS

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3.3 INSTALLATION OF CONTACTORS

- A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 INSTALLATION OF WIRING

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).
- B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.
- C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

- A. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by owner.
- B. Tests and Inspections:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Nonconforming Work:
 - 1. Lighting control devices will be considered defective if they do not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- D. Prepare test and inspection reports.
- E. Manufacturer Services:
 - 1. Engage factory-authorized service representative to **supervise** field tests and inspections.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within **12** months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to **two** visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

END OF SECTION 26 09 23

SECTION 26 09 43 – NETWORK/ADDRESSABLE LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Lighting control system
 - 2. Relays
 - 3. Switches

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop drawings: Project specific connection diagrams and riser diagrams

1.3 INFORMATIONAL SUBMITTALS

- A. Not required

1.4 CLOSEOUT SUBMITTALS

- A. Operating Instructions:
 - 1. Installation and programming instructions for all system components.
 - 2. Operating instructions for all system components.
 - 3. Relay schedule documentation.
 - 4. Switch schedule documentation.
 - 5. Time Clock schedule documentation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 SYSTEM

- A. Furnish and install a complete low voltage lighting control system consisting of relay control panels, switches and wiring to provide control as shown on the drawings.

- B. System shall be a 'Digital Lighting Management' System as manufactured by WattStopper or equivalent.
 - 1. System shall be furnished with a handheld display unit for system programming and time clock functions.
- C. System shall be networked to allow complete system control from any switch location, or setup as a hybrid approach allowing networking to be limited to the common areas and site. Refer to lighting control matrix for list of spaces to be networked vs standalone.
- D. Contractor shall include the local manufacturer's rep to program the system as shown in contract documents.
 - 1. Contractor shall furnish panel directories indicating circuit designation, and area designation for each relay.

2.3 RELAYS

- A. Relays shall be mounted in control panels containing terminal strips, transformers, rectifiers, all interconnecting wiring and switch interface modules for multiple relays. Relays shall maintain position during power outages.
- B. Low Voltage Relays shall be 20A rated, mechanically held, with manual by-pass built-in.

2.4 SWITCHES

- A. Switches shall be RJ45 connections via Category 5 cable (or better). The cabling shall be designed for open topology.
- B. Switches shall have engraving per the drawings and engraving matrix.
- C. Switches shall have LEDs indicating on/off status.
- D. Switches shall be capable of being configured to control a single relay, a group of relays, or scene control.
- E. Lighting Switches shall be Watt Stopper DLM as indicated on the drawings/wiring diagrams, or equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install per manufacturer's recommendations. Reference lighting control matrix for further detail on settings, meetings, and training necessary upon installation.

3.2 WIRING

- A. All wiring shall be as required by the equipment supplier and tested prior to connection.
- B. Wiring may be run as concealed open-type plenum rated cable. Exposed or inaccessible wiring shall be installed in conduit. Where possible wiring/conduit shall be concealed.

3.3 TESTING AND CHECKOUT

- A. The Contractor shall provide a representative from the company to conduct a 2-hour training class at a time scheduled in advance with the Owner and shall occur during or immediately following system startup. These instructions are to be conducted during normal working hours. All pertinent costs shall be included in this contract.
- B. A follow up visit is required 3 months after occupancy to allow for adjustments desired by owner after use of the system.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, boxes, cabinets, and terminals. Comply with identification requirements specified in Section 260553 "Identification for Electrical Systems."
- B. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with Section 260553 "Identification for Electrical Systems."
- C. Identify all ceiling-mounted controls with data bus number and device address.
- D. Label each device cable within 6 inch (152 mm) of connection to bus power supply or termination block.

3.5 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Test continuity of each circuit.
- B. Field tests must be witnessed by owner.
- C. Tests and Inspections:
 - 1. Test each bus controller using local and remote controls.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
- D. Nonconforming Work:
 - 1. Lighting controls will be considered defective if they do not pass tests and inspections.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

E. Field Test Reports:

1. Prepare test and inspection reports, including a certified report that identifies bus controllers included and describes query results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.
2. Printed list of all points created from actual queries of all addressed control points to include lamps, ballasts, manual controls, and sensors.
3. Event log verifying the performance of all devices generating event messages to include occupancy sensors, control buttons, alarm messages, and any other change of value messages.

3.6 STARTUP SERVICE

- A. The Contractor shall provide a representative from the company to conduct a 2-hour training class at a time scheduled in advance with the Owner and shall occur during or immediately following system startup. These instructions are to be conducted during normal working hours. All pertinent costs shall be included in this contract.
- B. **Engage a factory-authorized service representative to perform** startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Activate luminaires and verify that all lamps are operating at 100 percent.
 3. Burn-in fluorescent lamps at 100 percent for 100 hours.
 4. Confirm correct communications wiring, initiate communications between DALI devices and controller/gateways, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within **12** months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to **two** visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 26 09 43

SECTION 26 09 61 – THEATRICAL LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: **List**
- B. Furnish and install

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A.

2.3 PRODUCT A

- A.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing conditions....

3.2 INSTALLATION

- A. Provide
- B. Product A
 - 1.
 - 2.
- C.

3.3 CLEANING AND PROTECTION

- A. Clean

END OF SECTION 26 09 61

SECTION 26 12 19 – MEDIUM VOLTAGE PAD-MOUNTED LIQUID-FILLED TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Medium voltage pad-mounted liquid-filled transformers

1.2 ACTION SUBMITTALS

- A. Product Data
- B. Shop Drawings

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual
- B. Nameplate data
- C. Factory test results

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Eaton/Cooper Industries; Cooper Power Systems Division.
- B. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.

- C. ABB/GE Electrical Distribution & Control.
- D. Hammond Manufacturing; Transformer Group.
- E. Siemens Energy & Automation, Inc.
- F. Schneider Electric.
- G. MGM Transformer Co.

2.3 GENERAL

- A. Three phase dead-front.
- B. 300kVA
- C. 4,160 Delta – 208Y/120V
- D. Two 2-1/2% above and two 2-1/2% below hot-stick operated tap changers.
- E. Transformer shall have a feed through loop switches independently operable along with a radial ON/OFF fused switch.
- F. Wells for loadbreak or deadbreak elbows
- G. [Low voltage bushings shall be tinned spade type with four 9/16” holes]
- H. Elbow parking stands

2.4 ACCESSORIES:

- A. 1” drain valve.
- B. Separate 1/2” oil sampler device.
- C. Dial type thermometer mounted in a well with resettable high temperature slave hand indicator.
- D. Oil filling fitting.
- E. Liquid level gauge.
- F. Self-actuated pressure release device to vent pressure at 10 psig.
- G. Provisions for a vacuum/pressure gauge (1/4” NPT).
- H. Vacuum/pressure gauge with range of -10 psig to +10 psig.

- I. Furnish a [3] KV surge arrestor in transformer tank.

2.5 IDENTIFICATION DEVICES

- A. Nameplates:
- B. Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws.
- C. 6" wide x 2" high
- D. Reading as follows:
- | | |
|---------------------------------------|------------------|
| "TRANSFORMER IDENTIFICATION" | (5/8" Lettering) |
| ____ KVA | (3/8" Lettering) |
| PRIMARY: ____ V ____ Ph ____ W ____ | (3/8" Lettering) |
| SECONDARY: ____ V ____ Ph ____ W ____ | (3/8" Lettering) |
| FEEDS _____ | (3/8" Lettering) |
| FED FROM _____ | (3/8" Lettering) |

PART 3 - EXECUTION

- A. SOURCE QUALITY CONTROL
1. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to ANSI C57.12.50 and IEEE C57.12.91.
- B. INSTALLATION
1. Install transformers on concrete bases.
 - a. Refer to pad details on drawings.
 - b. Anchor transformers to concrete bases according to manufacturer's written instructions and seismic codes at Project.
 - c. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 6 inches high.
 - d. Use 3000-psi, 28-day compressive-strength concrete and reinforcement.
 - e. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - f. Install epoxy-coated anchor bolts, for supported equipment, that extend through concrete base and anchor into structural concrete floor.
 - g. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

END OF SECTION 26 12 19

SECTION 26 13 00 – MEDIUM-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: **6-Way & 3-Way Switchgear**
- B. Furnish and install

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. S&C Vista

2.3 MEDIUM-VOLTAGE CIRCUIT BREAKER SWITCHGEAR

2.4 MEDIUM-VOLTAGE FUSIBLE INTERRUPTER SWITCHGEAR

- A. Metal-enclosed, air-interrupter switchgear, with fuses, complying with IEEE C37.20.3.

- B. Ratings: Comply with IEEE C37.04; and suitable for application in three-phase, 60-Hz, solidly grounded-neutral system.
- C. System Voltage: 13.2 kV nominal; 13.2 kV maximum
- D. Fuses: Sizes recommended by secondary unit substation manufacturer, considering
 - 1. fan cooling, temperature-rise specification, and cycle loading.
 - 2. Current-Limiting Fuses: Full-range, fast-replaceable, current-limiting type that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from tube.
 - 3. Indicator integral with each fuse to show when it has blown.
 - 4. Spares: Include three fuses in use and three spare fuses in storage clips in each switch.

2.5 MEDIUM-VOLTAGE VACUUM INTERRUPTER SWITCHGEAR

2.6 PAD-MOUNTED MEDIUM-VOLTAGE LIVE FRONT FUSIBLE SWITCHGEAR

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing conditions....

3.2 INSTALLATION

- A.
- B.

3.3 CLEANING AND PROTECTION

- A. Clean

END OF SECTION 26 13 00

SECTION 26 22 13 – LOW-VOLTAGE DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. 600 volts and below dry-type transformers

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Enclosure dimensions
 - 2. KVA rating
 - 3. Primary and secondary nominal voltages
 - 4. Voltage taps
 - 5. Weight
 - 6. Insulation class
 - 7. Temperature rise
 - 8. Core and coil materials
 - 9. Impedances
 - 10. Audible noise level
 - 11. Inrush data

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Schneider Electric

- B. General Electric by ABB
- C. Hevi Duty, Siemens
- D. Eaton Cutler-Hammer.

2.3 DRY-TYPE TRANSFORMERS

- A. Furnish and install, as indicated on the electrical plans, dry type transformer as manufactured by Square D Company, General Electric by ABB, Hevi Duty, Siemens, or Eaton Cutler-Hammer.
- B. Three phase transformers shall have a delta primary (unless noted otherwise on the drawings) and a secondary as noted on the drawings.. Transformer shall have a minimum of 4 2 1/2% full current below normal and 2 2 1/2% full current above normal taps. For < 350V - Transformer shall have a minimum of 2 5% full current below normal and 1 5% full current above normal taps.
- C. Transformers shall be ANSI Class AA (Self-Cooled), as defined by ANSI-C57.12.01. Transformers shall be 115°C-temperature rise above 40°C ambient. 115°C rise transformers shall be capable of carrying a 15% continuous overload without exceeding a 150°C rise in a 40°C ambient. All insulating materials to be in accordance with NEMA ST20 2014 standards for a 220°C UL component recognized insulation system.
- D. Transformer efficiency shall be in accordance with the latest version of DOE 10 CFR 431.196.
- E. Provide copper windings.
- F. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 - 2. Indicate value of K-factor on transformer nameplate.
- G. Provide a 4"wide x 1 1/2" high phenolic nameplate reading the following for each switch:

kVA TRANSFORMER IDENTIFICATION	(3/8" Lettering)
FEEDS LOAD NAME	(3/8" Lettering)
FED FROM SOURCE NAME	(1/4" Lettering)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide a housekeeping pad.
- B. Tops of transformers shall be marked to prohibit storage on transformers.

END OF SECTION 26 22 13

SECTION 26 24 13 – SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Main switchboard
 - 2. Distribution switchboards

1.2 ACTION SUBMITTALS

- A. Product Data
- B. Shop Drawings

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Schneider Electric
- B. General Electric by ABB
- C. Siemens
- D. Eaton Cutler Hammer.

2.3 GENERAL

- A. Switchboards shall be furnished and installed as shown on the drawings and specified below.
- B. The switchboards shall be dead front with front accessibility only in NEMA 1 enclosure.
- C. The switchboards' bussing shall be [plated copper] sized in accordance with UL 891 and have a minimum short circuit rating of 50,000 RMS symmetrical amperes.
- D. All protective devices installed in the Switchboard shall have a kAIC rating to match the switchboard kAIC rating unless otherwise noted.
- E. Provide 6" wide x 2" high phenolic switchboard nameplates reading the following:

SWITCHBOARD MDPA	(5/8" Lettering)
480/277V 3PH 4W 3000A	(3/8" Lettering)
50kAIC FULLY RATED	(3/8" Lettering)
FED FROM UTILITY TRANSFORMER	(3/8" Lettering)

SWITCHBOARD MDPB	(5/8" Lettering)
480/277V 3PH 4W 1200A	(3/8" Lettering)
50kAIC FULLY RATED	(3/8" Lettering)
FED FROM UTILITY TRANSFORMER	(3/8" Lettering)
- F. Provide labeling indicating Available Fault Current with calculation date Per NEC 2020 408.6.
- G. Fusible switches or circuit breakers shall be provided in the sizes and arrangements shown on the drawings. Provide a 3" wide x 1" high phenolic nameplate for each switch/breaker as follows:

EQUIPMENT IDENTIFICATION	(3/8" Lettering)
__AS/ __AF (XX AMP SWITCH/XX AMP FUSE)	(1/4" Lettering)
- H. The utility metering compartment shall be located in the top half of the main switchboard service entrance section.
- I. The customer metering compartment shall be located in the top half of the main switchboard service entrance section. Digital metering shall be as specified in 26 27 13.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide housekeeping pads for floor mounted switchboards

END OF SECTION 26 24 13

SECTION 26 24 16 – PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards
 - 2. Circuit breaker panelboards

1.2 ACTION SUBMITTALS

- A. Product Data
- B. Shop Drawings

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Schneider Electric
- B. General Electric by ABB
- C. Siemens
- D. Eaton Cutler Hammer.

2.3 DISTRIBUTION PANELBOARDS

- A. Panelboards shall be installed as shown on the drawings and specified below.
- B. Panels shall be dead front type, with fusible switches or circuit breakers furnished in sizes as indicated on drawings.
- C. The panels shall include an equipment grounding bus.
- D. Main buses and connectors shall be copper of sufficient current carrying capacity to limit the temperature rise to 65KC per UL tests and have a minimum short circuit rating of 10,000A (120/208V) or 14,000A (277/480V) or as noted on the drawings.
- E. All protective devices installed in the distribution panelboard shall have a kAIC rating to match the distribution panelboard kAIC rating unless otherwise noted.
- F. All main bus joints, tap connections, and contact points shall be silver or tin-plated.
- G. Provide a 6" wide x 2" high phenolic panelboard nameplate reading the following:

PANELBOARD IDENTIFICATION	(5/8" Lettering)
__ V __ Ph __ W __ A	(3/8" Lettering)
__ kAIC FULLY RATED	(3/8" Lettering)
FED FROM ____	(3/8" Lettering)
- H. Provide labeling indicating Available Fault Current with calculation date Per NEC 2020 408.6.
- I. Fusible Switches and Circuit Breakers: Fusible switches and circuit breakers shall be provided in the sizes and arrangements shown on the drawings. Fusible switches shall accept Class R fuses.
- J. Provide a 3" wide x 1" high phenolic nameplate for each switch as follows:

EQUIPMENT IDENTIFICATION	(3/8" Lettering)
__ AS/ __ AF (XX AMPS WITH/XX AMP FUSE)	(1/4" Lettering)
- K. The switches shall be provided with a door interlock to prevent access to fuses and switch when energized and manually operated interlock defeat mechanism. The door is to be furnished with "on off" handle position markings and a means to lock the switch in the open position is to be provided.

2.4 ELECTRICALLY CONTROLLED PANELBOARDS

- A. PANELBOARDS
 - 1. Panelboard shall be equipped with a Master Controller to allow for programming and operation of the electronically controlled breakers.
 - 2. Intelligent panelboards shall use standard boxes, interiors, and trims. Panelboard shall not require different construction to accommodate control components. All control components shall install onto standard panelboard interiors. Control components shall not restrict field wiring in gutter space.
 - 3. All intelligent panelboards shall be provided with remotely operated circuit breakers and intelligent control bus providing interface to remotely operable circuit breakers. Panelboards shall accept a mix of standard and remotely operated circuit breakers.

4. The intelligent panelboard system shall fully accommodate the separation of Class 1 and Class 2 control circuits as required by the NEC. The control bus shall be a UL-listed Class 1 control device for installation in the same panelboard gutter with field-installed power circuits. Intelligent panelboards using control bus devices that are not specifically listed as UL Class 1 shall be provided with physical barriers to completely separate field wiring from the control bus, circuit breaker connections, and all associated Class 2 wiring.
5. System Power Supply: The system power supply shall mount on the panelboard interior and be fed directly from the panelboard bus without external wiring or fuses. The power supply shall provide isolated Class 1 and Class 2 sources to allow field wiring to meet NEC requirements. Each power supply shall provide capacity for 8 control busses with 168 circuit breakers in up to 8 panelboards, and one controller.

B. REMOTELY OPERATED CIRCUIT BREAKERS

1. Remotely operated branch circuit breakers shall provide overload and short circuit protection suitable for the location in the electrical system, as defined in the panelboard schedules. Remotely operated power switching devices shall have the following:
 - a. Integral branch circuit overcurrent protection as required by the NEC. Circuit breakers shall have a UL-listed interrupting rating sufficient for the application or UL-listed series connected ratings for the maximum available fault current at that point in the system. Submittals reflecting the use of relays or contactors to perform remote switching shall show evidence in writing that the relays or contactors are listed to withstand the available fault current.
 - b. UL-listed SWD ratings for 15 ampere, 20 ampere, and 30 ampere 1-pole, 2-pole, and 3-pole branch devices, HID ratings, and HACR ratings.
 - c. Handle operator that shall mechanically open the power switching device contacts when moved to the OFF position and disable the contacts from being remotely closed. Handle operator shall accept field-installable handle tie to allow application where a handle tie is required by the NEC.
 - d. Manual override switch to enable or disable the remote operation of the device and allow circuit breaker handle to fully control the on/off state of the circuit breaker. Override shall fully disengage remote operation of the circuit breaker mechanism. Device utilizing one-shot or temporary overrides shall not be accepted.
 - e. Visible flag that clearly indicates the status of the circuit breaker contacts with the panel trim installed. Flag shall indicate ON, OFF, and TRIPPED circuit breaker states. The visible flag shall be mechanical in nature, directly tied to the circuit breaker mechanism, and shall be provided in addition to any status indicator supplied by the system electronics.
 - f. Voltage status signal to indicate the presence or absence of voltage at the load terminal as a true indication of the on/off status of the connected circuit to aid in identifying wiring errors, such as a back-feed or disconnected neutral conductor.
 - g. Circuit to indicate the number of poles of the remotely operable circuit breaker.
 - h. Integral control connector to simplify and speed installation and eliminate wiring errors such that the control connection is made automatically when installing the breaker in the panelboard. Connection to the breaker shall not introduce control wiring into the panelboard gutter space. Control connections shall be rated NEC Class 1 to eliminate the requirement for barriers in the gutter space such that control connections may reside with electrical power circuit conductors.
 - i. Switching full load endurance rating of 200,000 open/close/open remote operations. Switching devices with lower ratings or no published ratings may be judged to be

acceptable, but shall be provided with 100% spare switching devices for each circuit to ensure an equivalent total number of operations.

- 2.
- 3.

2.5 CIRCUIT BREAKER PANELBOARDS

- A. Panels shall be dead front, safety type, furnished with branch circuit protecting devices, equipment grounding bus, phenolic nameplate, main bus and cable lugs factory assembled, with all components in place, ready for installation. Contractor to determine top or bottom feed for lug placement. Feed locations shall not be reviewed by the Engineer.
- B. The circuit breakers shall be of the molded case, bolt on type suitable for voltage and ampere ratings indicated on drawings and in schedules and shall have a minimum interrupting capacity of 10,000 amperes (120/208V) or 14,000 amperes (277/480V) or as noted on the drawings.
- C. Provide lockable red circuit breakers on all circuits serving the fire alarm system.
- D. Buses and connectors shall be silver or tin plated hard drawn copper of 98% conductivity, with current carrying capacity to maintain established rise tests as defined in UL Standard UL 67.
- E. A directory frame shall be attached to inside face of hinged door. The directory card shall be neatly typed to identify circuits. A transparent plastic facing shall protect the directory card. Room numbers shall be included in directory descriptions. Furnish a copy of each panel directory to the Architect/Engineer. Where existing panelboard loads are modified, the panel directories shall be updated.
- F. Provide labeling indicating Available Fault Current with calculation date Per NEC 2020 408.6.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide housekeeping pads for floor mounted panelboards.
- B. All flush mounted panelboards shall have spare 1" conduits stubbed up out of the panelboard and extended to above an accessible ceiling. Panelboards in interior wall shall have two conduits stubbed out on both sides of the wall (four conduits total). Panelboards in exterior walls shall have three conduits stubbed out into the building interior.

END OF SECTION 26 24 16

SECTION 26 27 13 – METERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Main switchboard metering

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual

1.4 CLOSEOUT SUBMITTALS

- A. Operation Manual

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Schneider Electric/Square D PowerLogic PM820 or equivalent

2.3 METERS

- A. The monitors shall have the ability to display real-time voltage, current, real power, reactive power, apparent power, power factor, and frequency. The meter shall also be capable of alarming, logging, and waveform capture based upon setup values and limits.
- B. Provide CT's and all power connections as required.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Factory installed.

END OF SECTION 26 27 13

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General-use switches, dimmer switches, and fan-speed controller switches.
2. General-grade single straight-blade receptacles.
3. General-grade duplex straight-blade receptacles.
4. Hospital-grade straight-blade receptacles.
5. Receptacles with arc-fault and ground-fault protective devices.
6. Locking receptacles.
7. Pin-and-sleeve receptacles.
8. Special-purpose power outlet assemblies.
9. Connectors, cords, and plugs.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260923 "Lighting Control Devices" for occupancy sensors, timers, control-voltage switches, and control-voltage dimmers.
3. Section 262726.11 "General-Use Switches, Dimmer Switches, and Fan-Speed Controller Switches" for additional wiring device products.
4. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for additional wiring device products.
5. Section 262726.37 "Receptacles with Arc-Fault and Ground-Fault Protective Devices" for additional wiring device products.
6. Section 262726.39 "Locking Receptacles" for additional wiring device products.
7. Section 262726.43 "Special-Purpose Power Outlet Assemblies" for additional wiring device products.

1.2 DEFINITIONS

- A. Commercial/Industrial-Use Cord Reel: A cord reel subject to severe use in factories, commercial garages, construction sites, and similar locations requiring a harder service-type cord.

1.3 ACTION SUBMITTALS

- A. Product Data:

1. General-use switches, dimmer switches, and fan-speed controller switches.
2. General-grade single straight-blade receptacles.
3. General-grade duplex straight-blade receptacles.
4. Receptacles with arc-fault and ground-fault protective devices.
5. Locking receptacles.
6. Pin-and-sleeve receptacles.
7. Special-purpose power outlet assemblies.
8. Connectors, cords, and plugs.

B. Shop Drawings:

1. Wiring diagrams for duplex straight-blade receptacles with integral switching means.

1.4 CLOSEOUT SUBMITTALS

- A. Operating Instructions: For each type of product.

PART 2 - PRODUCTS

2.1 DEVICES:

Receptacles	Hubbell	Leviton	P & S
20A Duplex	HBL5362	5362A	5362A-I
20A GFI	GF20L	7899	2095-I
20A Duplex w/ USB	USB20ACW	T5833	TR20USBAC6W

Switches	Hubbell	Leviton	P & S
20A Single	1221	1221-2	PS20ACI
20A 3-way	1223	1223-2	PS20AC3
20A 4-way	1224	1224-2	PS20AC4
20A 2 pole	1222	1222-2	PS20AC2

Nylon Plates	Hubbell	Leviton	P & S
Duplex	NP8	80703	TP8
Quadplex	NP82	80716	TP82
Single Toggle	NP1	80701	TP1
2-Gang Toggle	NP2	80709	TP2
GFI	NP26	80401-N1	TP26

2.2 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Toggle Switch:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

- a. Reference Standards: UL CCN WMUZ and UL 20.

3. Options:

- a. Device Color: As indicated on architectural Drawings.

4. Accessories:

- a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.3 GENERAL-GRADE SINGLE STRAIGHT-BLADE RECEPTACLES

A. Single Straight-Blade Receptacle:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

- a. Reference Standards: UL CCN RTRT and UL 498.

3. Options:

- a. Device Color: As indicated on architectural Drawings.

4. Accessories:

- a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.4 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

A. Duplex Straight-Blade Receptacle:

1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
3. Options:
 - a. Device Color: As indicated on architectural Drawings.
4. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.5 RECEPTACLES WITH ARC-FAULT AND GROUND-FAULT PROTECTIVE DEVICES

A. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:

1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. General Characteristics:
 - a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
3. Options:
 - a. Device Color: As indicated on architectural Drawings.
4. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.6 LOCKING RECEPTACLES

A. NEMA, 125 V, Locking Receptacle <Insert drawing designation>:

1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
3. Options:
 - a. Device Color: Black with yellow voltage indication on face.
 - b. Configuration: 2 pole, 3 wire, grounding, as required for equipment.

B. NEMA, 250 V, Locking Receptacle <Insert drawing designation>:

1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
3. Options:
 - a. Device Color: Black with blue voltage indication on face.
 - b. Configuration: As required for equipment.

2.7 SPECIAL-PURPOSE POWER OUTLET ASSEMBLIES

A. Power Outlet Cord Management Assembly:

1. Source Limitations: Obtain all components for each power outlet cord management assembly from single manufacturer.
2. Regulatory Requirements: Components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
3. General Characteristics: Provide the following specified products with fabricated power outlet cord management assembly:
 - a. Cord Management System:

- 1) Spring-driven commercial/industrial-use cord reel, 12AWG conductors.
 - b. Termination Fitting:
 - 1) Outdoor-use, watertight, sealed cord connector.
 4. Options:
 - a. Mounting: Ceiling.
- B. Spring-Driven Commercial/Industrial-Use Cord Reel, No. 12 AWG Conductors
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 2. General Characteristics:
 - a. Reference Standards: UL CCN SBCV and UL 355.
 - b. Spring take-up retraction mechanism.
 3. Options:
 - a. Electrical Rating with Cable: 600 V, 25 A.
 - b. Color: Yellow.
 - c. Enclosure Degree of Protection: Type 4.
 - d. Ball stop.
 - e. Pivot base.
 - f. Spool Capacity:
 - 1) No. 12 AWG, two wires and equipment ground, 30 ft (9.1 m).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receptacles:
1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.
- B. Cord Reels:
1. Examine roughing-in for cord reel mounting and power connections to verify actual locations of mounts and power connections before cord reel installation.
 2. Examine walls, floors, and ceilings for suitable conditions where cord reel will be installed.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SWITCHES

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
 - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
 - 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
 - 3. Consult Architect for resolution of conflicting requirements.
- C. Identification:
 - 1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
 - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
- D. Interfaces with Other Work:
 - 1. Coordinate installation of new products with existing conditions.

3.3 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
 - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
 - 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
 - 3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
 - 4. Consult Architect for resolution of conflicting requirements.
- C. Identification:
 - 1. Identify cover or cover plate for device with panelboard identification and circuit number.
 - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
- D. Interfaces with Other Work:

1. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.

3.4 INSTALLATION OF CORD REELS AND FITTINGS

- A. Comply with manufacturer's instructions.
- B. Interfaces with Other Work:
 1. Coordinate installation of new products with existing conditions.

3.5 FIELD QUALITY CONTROL OF SWITCHES

- A. Tests and Inspections:
 1. Perform tests and inspections in accordance with manufacturers' instructions.
- B. Nonconforming Work:
 1. Unit will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective units and retest.
- C. Assemble and submit test and inspection reports.

3.6 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

- A. Tests and Inspections:
 1. Insert and remove test plug to verify that device is securely mounted.
 2. Verify polarity of hot and neutral pins.
 3. Measure line voltage.
 4. Measure percent voltage drop.
 5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
- B. Nonconforming Work:
 1. Device will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective units and retest.
- C. Assemble and submit test and inspection reports.

3.7 FIELD QUALITY CONTROL OF LOCKING RECEPTACLES

- A. Tests and Inspections:
 1. Insert and remove test plug to verify that device is securely mounted.
 2. Verify polarity of hot and neutral pins.

3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

B. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

3.8 FIELD QUALITY CONTROL OF CORD REELS AND FITTINGS

A. Tests and Inspections:

1. Perform tests and inspections indicated in manufacturer's instructions.

B. Nonconforming Work:

1. Components and assemblies will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Assemble and submit test and inspection reports.

3.9 ADJUSTING

- A. Cord Reels and Fittings: Adjust spring mechanisms and moving parts of cord reels and fittings to function smoothly, and lubricate as recommended in writing by manufacturer.

3.10 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

B. Cord Reels and Fittings:

1. After installation, protect cord reels and fittings from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

C. Connectors, Cords, and Plugs:

1. After installation, protect connectors, cords, and plugs from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262726

SECTION 26 28 13 – FUSES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fuses

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Not required

1.4 CLOSEOUT SUBMITTALS

- A. Not required

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Bussmann
- B. Mersen

2.3 FUSES

- A. Electrical Contractor shall furnish and install a complete set of fuses as manufactured by the Bussmann Company or Mersen Electrical Power (Ferraz Shawmut), sized for ordinary service of motors and other loads served and at each safety switch installed as shown on the drawings and as hereinafter specified.

- B. Fuses for motor loads and all other loads up to 600 A and up to 600 V shall be Buss “Low Peak” or Mersen Amptrap 2000 dual element fuses, having a minimum interrupting capacity of 200,000 A RMS symmetrical. The fuses shall be UL Class RK1.
- C. Fuses for all loads above 600 A and up to 600 V shall be Buss “Low Peak” or Ferraz Mersen Amptrap 2000 current limiting, time delay fuses, with a minimum interrupting capacity of 200,000 A RMS symmetrical. The fuses shall be UL Class L.
- D. The installation of fuses of mixed manufacturers shall not be accepted. Fuse of only one manufacturer shall be installed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Upon completion of the building construction, the Contractor shall provide a complete set of three spare fuses for each size and type used. [Furnish and install a spare fuse cabinet equivalent to Bussmann Model SFC.]

END OF SECTION 26 27 13

SECTION 26 28 16 – DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fuses

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Not required

1.4 CLOSEOUT SUBMITTALS

- A. Not required

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Siemens
- B. Schneider Electric
- C. Eaton Cutler Hammer
- D. General Electric by ABB

2.3 DISCONNECT SWITCHES

- A. Type of Switch: Furnish and install disconnect switches as specified where shown on the drawings.

- B. All disconnect switches shall be classed Heavy Duty and enclosed as required by NEMA Standards. Switch sizes and fusing shall be as shown on the drawings.
- C. Switch shall have a quick make, quick break mechanism operating through the box and not the cover. The switchblades shall be visible when the hinged door is open.
- D. The cover shall be interlocked with the operating handle to prevent opening door when switch is "ON" and a means provided to lock switch in the "OFF" position. This mechanism shall be capable of being defeated.
- E. Provide a 4" wide x 1½" high phenolic nameplate reading the following for each switch:
 - 'EQUIPMENT IDENTIFICATION'** (3/8" Lettering)
 - SERVICE DISCONNECT** (3/8" Lettering)
 - FED FROM 'SOURCE NAME'** (1/4" Lettering)
 - LOCATE IN 'SOURCE LOCATION'** (1/4" Lettering)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install nameplates as described above.

END OF SECTION 26 27 13

SECTION 26 28 19 – ELEVATOR POWER MODULE SWITCH

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Elevator power module switches

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Not required

1.4 CLOSEOUT SUBMITTALS

- A. Operation manual

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Bussmann Power Module Switch
- B. Mersen
- C. Eaton Cutler Hammer

2.3 ELEVATOR POWER MODULE SWITCHES

- A. Power for the elevator shall be provided as indicated on the plans. The electrical contractor shall furnish and install conduit and wire to extend the feeder from the elevator equipment disconnect in the elevator room to the terminal lugs on the elevator equipment.

- B. The elevator motor disconnect shall be a fused Bussmann Power Module Switch (or equivalent by Mersen or Eaton Cutler Hammer) with a shunt trip. The switch shall include a 120 volt control power transformer, fire safety interface relay with 120 volt coil, key test switch, green "on" pilot light, and shunt trip voltage monitoring relay.
- C. The switch shall also include a mechanical interlock-auxiliary contact wired to disconnect the battery-operated car lowering device when the switch is manually opened. The auxiliary contact shall remain closed when the switch is tripped.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The fire alarm safety relay shall be interlocked with the fire alarm system to shunt trip the switch upon alarm of any of the elevator hoist way or elevator equipment room heat detectors. The key test switch will simulate this alarm condition.
- B. The heat detectors shall be located within two feet of each sprinkler head.
- C. The exact location of all elevator devices shall be coordinated with the elevator manufacturer.

END OF SECTION 26 27 19

SECTION 26 29 13 – MOTOR AND APPLIANCE CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Magnetic motor starters
 - 2. Manual motor starters
 - 3. Selector switches and pushbuttons
 - 4. Relays
 - 5. Control devices
 - 6. Interconnection wiring
- B. Electrical Contractor shall furnish and install all electrical devices incident to the work except as otherwise stated herein. The Mechanical Contractor will furnish prewired control panels for equipment so indicated on the plans and will furnish EP switches, electrical thermostats, pressure switches and other temperature control devices as required by the specific sequence of operation for installation by the Electrical Contractor. Others will do testing and adjusting of mechanical system devices.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Schneider Electric / Square D
- B. Eaton Cutler Hammer
- C. Allen Bradley
- D. Siemens
- E. General Electric
- F. ABB

2.3 MOTOR AND APPLIANCE CONTROL

- A. The motor and appliance control devices shall be as follows:
 - 1. All starters shall be installed in NEMA 1 Enclosure unless noted otherwise on the drawings. Where noted other than NEMA 1, furnish the indicated NEMA rated enclosure.
 - 2. Single Phase Magnetic Starters Square D Class 8536 with one overload, 120 volt coil, N.O. auxiliary contacts, heavy-duty 30 mm and hand off automatic selector switch in cover all in an oversized NEMA enclosure.
 - 3. Three Phase Manual Starters Square D Class 2510 Type M, push button operated, lock-out guard, three thermal overloads in a NEMA enclosure. Furnish with or without pilot light and auxiliary contacts as indicated on drawings.
 - 4. Three Phase Magnetic Starters Square D Class 8536 with three overloads, 120 volt control transformer with 2 primary and 1 secondary fuses, heavy-duty 30 mm, hand off automatic selector switch, heavy-duty 30 mm pilot light, and extra N.O. auxiliary contacts all in a NEMA enclosure.
 - 5. Three Phase Combination Starter and Fusible Disconnect Switch Square D Class 8538 with a NEMA enclosure including a three pole fusible switch and a starter with three overloads, 120 volt control transformer with 2 primary and 1 secondary fuses, heavy-duty 30 mm, hand off automatic selector switch and heavy-duty 30 mm pilot light and N.O. auxiliary contacts.
 - 6. Fractional HP Single Phase Manual Starters Square D Class 2510 Type F, toggle switch operated with lock-out guard, single thermal overload. Furnish starters single speed with or without pilot lights as indicated on the drawings. All surface mounted starters shall be mounted in a 'FS' conduit box.
 - 7. Integral HP Single Phase Manual Starters – Square D Class 2510 Type M, push button operated, lock-out guard, single thermal overload in NEMA enclosure. Furnish with or without pilot light and auxiliary contacts as indicated on drawings.
 - 8. Selector Switches and Pushbutton Stations Square D Class 9001 heavy duty 30 mm in NEMA enclosure.

9. Provide a 3" wide x 1½" high phenolic nameplate reading the following for each motor starter:

EQUIPMENT IDENTIFICATION	(3/8" Lettering)
Size ' ', _A Overload	(1/4" Lettering)
FED FROM _____	(1/4" Lettering)
10. Relays Square D Class 8501 with 120-volt coil in NEMA 1 enclosure. Furnish with number of poles indicated on the plans.

PART 3 - EXECUTION

3.1 INSTALLATION

A. CONTROL AND INTERLOCK WIRING

1. The Electrical Contractor shall furnish and install control and interlock wiring as shown on the electrical drawings. Control and interlock wiring required by Division 22 or 25 but not shown on the electrical drawing shall be the responsibility of the Division 22 or 25 Contractor requiring the wiring.
2. Generally, this will mean that Division 26 wires the series safety circuit to the magnetic starters, furnished with Hand Off Auto selector switches, using switches and devices furnished by the Mechanical Contractor.
3. Starter automation, as required by the temperature control sequence of operation, will be provided and wired by Division 22 or 25 with connections made to terminals on the automatic side of the selector switch and on starter coil auxiliary contacts.
4. The intention is that Division 26 furnish and install all wiring necessary to operate the magnetic starters with the selector switch in the Hand position and that Division 22 or 25 provide all additional automation required.
5. Relays, electropneumatic relays, and any other device required by Division 22 or 25 to operate in parallel with the starter coil shall be controlled through spare auxiliary contacts on the starter furnished by Division 26 and shall not be connected to the starter coil.
6. Single-phase motors generally are controlled by line voltage controllers furnished by the Temperature Control Contractor but installed by the Electrical Contractor. If the control sequence is more complicated than a single line voltage device such as a unit mounted thermostat, a relay or control device with a horsepower rated contact will be provided by the Temperature Control Contractor for installation by the Electrical Contractor adjacent to the motor disconnect device. The Electrical Contractor shall provide power-wiring connections to this control device. Temperature Control Contractor will provide control and interlock wiring to this control device.

END OF SECTION 26 29 13

SECTION 26 29 23 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Variable frequency drives
 - 2. Control devices
 - 3. Interconnection wiring
- B. The Electrical Contractor shall provide variable frequency drives as shown on the drawings. The Electrical Contractor shall furnish and install the controller, control devices, and interconnection wiring as specified below.

1.2 ACTION SUBMITTALS

- A. Product Data
- B. Shop drawings
 - 1. Dimensioned drawings.
 - 2. Operation and installation manuals.
 - 3. Maintenance, adjustment, part breakdown and troubleshooting manual.
 - 4. Connection diagrams.
 - 5. Schematic diagrams including printed circuit boards, wiring harnesses, and enclosure mounted controls.

1.3 INFORMATIONAL SUBMITTALS

- A. Installation manual

1.4 CLOSEOUT SUBMITTALS

- A. Operation Manual:
- B. Parts List: For each type of product that has replaceable parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Toshiba Q9
- B. YASKAWA Z1000
- C. Danfoss FC 102
- D. ABB ACH 580.

2.3 DRIVE GENERAL DESCRIPTION

- A. Furnish and install variable frequency drives as specified herein. The assembly shall include a circuit breaker or input fuses, motor overload relay(s) and operational options required by this specification.
- B. A factory authorized trained technician shall make final adjustments and settings on the drives and shall submit a field report to the Engineer stating the setpoints and ramp time settings on each drive.

2.4 DRIVE COMPONENTS

- A. The variable frequency drive system shall include a diode bridge rectifier, DC link reactor for reduction of harmonics, capacitor filter, and IGBT inverter section. The output shall be capable of a 12khz sine coded pulse width modulated output for quiet operation. The drive ratings shall be based upon 8khz output.
- B. Refer to Mechanical Electrical Interface for maximum carrier frequency rating.
- C. For sound sensitive areas, the variable frequency drive system shall include a diode bridge rectifier, DC link reactor for reduction of harmonics, capacitor filter, and IGBT inverter section. The output shall be capable of a 12khz sine coded pulse width modulated output for quiet operation. The drive ratings shall be based upon 12khz output. Field tune carrier frequency at startup.

Per specifier note: Review plans for motors and VFDs located outside of mechanical rooms that would pose acoustical concerns.

Include VFD Special Conditions Feeder Schedule on plans

- D. The controller shall include the following devices:
1. Drive manual on off auto selector switch to manually energize or de energize the drive control system.
 2. Manual speed selector to allow a specified speed to be selected and maintained if the manual off automatic selector switch is in the manual position.
 3. [Integral line side disconnect switch or circuit breaker, contactors, and thermal overload relays for each motor on drives controlling multiple motors.]
 4. 4-20 milliamp output that is directly proportional to drive speed.
- E. Provide a 3" wide x 1" high phenolic nameplate for each starter or disconnect as follows:
- | | |
|---|-------------------------|
| EQUIPMENT IDENTIFICATION | (3/8" Lettering) |
| __AS/ __AF (XX AMP SWITCH/XX AMP FUSE) | (1/4" Lettering) |
- OR**
- | | |
|---------------------------------|-------------------------|
| EQUIPMENT IDENTIFICATION | (3/8" Lettering) |
| Size ‘_’, __A Overload | (1/4" Lettering) |
- F. The system protection as a minimum will provide the following:
1. Overcurrent protection of 100% continuous, 110% for 1 minute.
 2. Instantaneous overcurrent trip at 150%.
 3. Current limit stall prevention shall be adjustable 10 to 110%.
 4. Ground fault protection.
 5. Current limiting DC bus fuse.
 6. Overvoltage protection.
 7. Undervoltage protection.
- G. When the drive faults, the drive shall activate a 1NO, 1NC-fault relay display for indication of type of trip.
- | | | |
|----|-------|--------------------------------|
| 1. | OC: | Overcurrent trip at 150% |
| 2. | OCA: | Overcurrent on start up |
| 3. | OCL: | Overcurrent on output |
| 4. | OL: | Overload |
| 5. | OP: | Overvoltage due to power surge |
| 6. | OP2: | Overvoltage while deceleration |
| 7. | POFF: | Undervoltage |
| 8. | OH: | Overheat |
| 9. | EF: | Ground faults |
- H. Auto restart shall be a standard feature of the drive as follows:
1. Auto restart enabled or disabled by jumper or keypad selection.
 2. If auto restart is selected the microprocessor shall determine, in the event of a fault, if a restart should be attempted. A restart will be attempted under the following condition:
 3. Undervoltage (UP) Every time as soon as voltage returns to a safe level. Fault relay is not activated.
 4. Input Overvoltage (OPS) and DC Bus Overvoltage (OP) Every time if voltage returns to normal within 30 seconds, fault relay is not activated.
 5. Overcurrent (OC) Drive delays 1 second and attempts a restart. If drive trips a second time it delays 2 seconds and attempts a second restart. Overall, five attempts are made

after successive delays of 1, 2, 4, 8 and 16 seconds. If the restart fails, the drive locks out and sets the fault relay on. (Number of restarts and time delays to be adjustable via keypad or jumpers).

6. A restart will not be attempted for any other type of fault and the drive will trip out immediately, activate the fault relay and make the appropriate indication on the display.
- I. In the event of a fault trip the microprocessor shall save the status of the drive at the time of the fault and make that information available on the display until the drive is reset or the control power is removed.
- J. An undervoltage condition of less than 100 ms duration shall not affect drive operation. If main power falls below 85% of rated voltage for longer than 100 ms while control power is retained the drive shall forcibly decelerate the load in an attempt to force a higher bus voltage through regeneration. This feature, depending on the inertia of the load, shall allow the drive to “ride through” a longer condition.
- K. A minimum of 3% DC link or line reactor.
- L. Operation functions shall include the following:
 1. Acceleration and deceleration time independently adjustable from .1 to 1200 seconds.
 2. Signal follower 0 5VDC, 0 10VDC, 4 20ma, 0 20ma, 1 5VDC, or 0 135 ohms selectable. An increasing input signal can command increasing or decreasing frequency as required by the application.
 3. Ramp to stop or coast to stop for normal operation (coast to stop on fault).
 4. Volts/Hertz patterns selectable by keypad.
 5. Upper and lower frequency limit adjustments shall be available. When the drive reaches one of the limits it shall activate an open collector signal available to the user. A dry contact signal shall be available as an option.
- M. Drives shall have a Short Circuit Current Rating (SCCR) of 100,000 amps.
- N. Three Contactor By-Pass:
 1. Provide a three-contactor by-pass.
 2. Normal/by-pass selector switch.
 3. The bypass contactors shall be mechanically and electrically interlocked

2.5 INSTALLATION

- A. Provide housekeeping pads for all floor mounted equipment.
- B. Control and interlock wiring
 1. The Electrical Contractor shall furnish and install control and interlock wiring as shown on the electrical drawings. Control and interlock wiring required by Division 22 or 25 but not shown on the electrical drawing shall be the responsibility of the Division 22 or 25 Contractor requiring the wiring.
 2. Generally, this will mean that Division 26 wires the series safety circuit to the magnetic starters, furnished with Hand Off Auto selector switches, using switches and devices furnished by the Mechanical Contractor.

3. Starter automation, as required by the temperature control sequence of operation, will be provided and wired by Division 22 or 25 with connections made to terminals on the automatic side of the selector switch and on starter coil auxiliary contacts.
4. The intention is that Division 26 furnish and install all wiring necessary to operate the magnetic starters with the selector switch in the Hand position and that Division 22 or 25 provide all additional automation required.
5. Relays, electropneumatic relays, and any other device required by Division 22 or 25 to operate in parallel with the starter coil shall be controlled through spare auxiliary contacts on the starter furnished by Division 26 and shall not be connected to the starter coil.
6. Single-phase motors generally are controlled by line voltage controllers furnished by the Temperature Control Contractor but installed by the Electrical Contractor. If the control sequence is more complicated than a single line voltage device such as a unit mounted thermostat, a relay or control device with a horsepower rated contact will be provided by the Temperature Control Contractor for installation by the Electrical Contractor adjacent to the motor disconnect device. The Electrical Contractor shall provide power-wiring connections to this control device. Temperature Control Contractor will provide control and interlock wiring to this control device.

END OF SECTION 26 29 23

SECTION 26 41 13 – LIGHTNING PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Lightning protection system

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop drawings

1.3 INFORMATIONAL SUBMITTALS

- A. Not required

1.4 CLOSEOUT SUBMITTALS

- A. As-built drawings
- B. UL Master Label

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 LIGHTNING PROTECTION

- A. Provide all labor, material, equipment, and services to perform all operations required for the complete installation and related work as specified herein.
- B. An NFPA 780 system shall be designed and installed. The system shall conform to UL 96A (Lightning Protection Bulletin).
- C. The installation shall receive a UL Master Label prior to project completion.

- D. All materials shall be [Class I] [Class II] (Buildings below 75ft tall are Class I, above are Class II) Copper materials shall not be mounted on aluminum, galvanized steel, or zinc surfaces. Aluminum materials shall not come in contact with the earth or where rapid deterioration is possible. Aluminum and copper shall not come in contact with each other.
- E. The main conductors shall be sized as per [Class I] [Class II] standards. Conductors shall be free of excessive splices and no bend of a conductor shall form an angle of less than 90 degrees nor have a radius of bend less than 8 inches.
- F. Down conductors shall be sized as per [Class I] [Class II] standards. Down conductors shall be spaced at intervals averaging not more than 100 feet around the perimeter of the structure or as indicated on the drawings. [Down conductors shall be concealed]. A structure shall have no fewer than two down conductors.
- G. Grounding electrodes shall be connected to each down conductor. The ground rod electrode shall be copper-clad steel, minimum 5/8" diameter and ten feet long. The top of the ground rod electrode shall be located a minimum of two feet below grade and below the frost line. The connection between the electrode and down conductor shall be exothermically welded.
- H. [In the case of a structure built with a structural steel frame, the roof conductors may be connected to the steel frame instead of using down conductors. The connections to the frame shall be at intervals not exceeding 100 feet along the perimeter of the structure. The ground rod electrodes shall then connect to the structural steel at intervals not averaging more than 60 feet apart. The steel columns shall be grounded using bonding plates or exothermically welded.]

PART 3 - EXECUTION

3.1 LIGHTNING PROTECTION INSTALLATION

- A. All grounding systems within the building shall be bonded together. This shall include the lightning protections system, electrical service, communication, and antenna system grounding electrodes.

END OF SECTION 26 41 13

SECTION 26 43 13 – SURGE PROTECTIVE DEVICES (SPD)

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Surge protective devices (SPD's), formerly TVSS

1.2 ACTION SUBMITTALS

- A. Product Data
 - 1. Submittal shall include a copy of the SPD performance parameters listed at www.UL.com under Certifications, searching using Category Code: VZCA, to verify SCCR, VPR, MCOV, I-n, and Type 1 compliance with this specification. “Manufactured in accordance with” is not equivalent to UL listing and does not meet the intent of this specification.

1.3 INFORMATIONAL SUBMITTALS

- A. Installation Manual

1.4 CLOSEOUT SUBMITTALS

- A. Operations Manual

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Eaton
- B. Current Technology
- C. LEA
- D. APT

- E. Schneider Electric
- F. Environmental Potentials

2.3 STANDARDS

- A. Must be listed or comply with the most recent editions of:
 - 1. Underwriters Laboratories: UL1449 and UL 1283
 - 2. ANSI/IEEE C62.41.1-2002, C62.41.2-2002, C62.45-2002
 - 3. National Electrical Code: Article 285
 - 4. NEMA LS-1(rescinded Aug 19, 2009, replacement undetermined)

2.4 SURGE PROTECTIVE DEVICES

- A. SPD shall be UL labeled with a 200kA Short Circuit Current Rating (SCCR), as a Type 1 device, and a 20kA I-nominal (I-n) rating.
- B. Minimum surge current capability (single pulse rated) per phase shall be:
 - 1. Service Entrance: 300kA
 - 2. Distribution panelboards & MCC: 200kA
 - 3. Branch panelboards: 100kA
- C. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

<u>System Voltage</u>	<u>L-N</u>	<u>L-G</u>	<u>L-L</u>	<u>N-G</u>	<u>MCOV</u>
208Y/120	700V	700V	1200V	700V	150V
480Y/277	1200V	1200V	1800V	1200V	320V
- D. SPD shall include visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
- E. All units shall also include a surge counter mounted in the enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. SPD shall be installed in accordance with the manufacturer's installation manual using the recommended breaker and wire sizes.
- B. The SPD unit shall be located as close as is practical to the switch or circuit breaker serving the unit. All efforts shall be made to locate the switch or circuit breaker in a place where the SPD leads are as short as possible. In no case shall the factory SPD leads be extended or spliced.
- C. All of the SPD units shall be provided in a NEMA 1 or 12 enclosure, unless otherwise specified.

END OF SECTION 26 43 13

SECTION 26 51 00 – LED LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. LED luminaires
- B. Related Requirements:
 - 1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
 - 2. Section 26 09 43 "Network/Addressable Lighting Controls" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
 - 3. Drawings for Luminaire Schedule.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 6. Include sample warranty.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Submit factory drawings with the following additional information included:
 - a. Plans, elevations, sections, and mounting and attachment details.
 - b. Details of luminaire assemblies. Indicate dimensions of fixture including individual lens lengths, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - c. Diagrams for power, signal, control wiring, and emergency lighting locations.
 - d. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - e. Product Certificates: for each type of Luminaire.
 - f. Product Test Reports: For each luminaire, for test performed by a qualified testing agency.
 - g. Sample warranty.

1.3 PRODUCT SUBSTITUTIONS

- A. Product Substitutions shall be submitted 10 days in advance of bid-day. All products included in bid shall be of equal or better quality to the basis of design.

1.4 INFORMATIONAL SUBMITTALS

- A. Not required.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 - 1. Provide a list of all Lamps/LED Light Bars & Drivers/Transformers used on Project; use ANSI and manufacturers' codes.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps/LED Light Bars: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Drivers/Transformers: One for every 100 of each type and rating installed. Furnish at least one of each type.

1.7 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Refer to Luminaire Schedule on the drawings.

2.3 LED LIGHTING

A. Quality Assurance

1. Luminaire Photometric Data Testing Laboratory Qualifications:
 - a. Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
 - b. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
2. Provide luminaires from a single manufacturer for each luminaire type.
3. Each luminaire type shall be binned within a three-step MacAdam Ellipse or better to ensure color consistency among luminaires.

B. Warranty

1. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
2. Warranty Period: From date of Substantial Completion.
 - a. Manufacturer: Five years minimum, unless otherwise noted.
 - b. Installer: One year minimum, unless otherwise noted.

C. Performance Requirements

1. Seismic Performance:
 - a. Luminaires shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
 - b. Luminaires and lamps shall be labeled vibration and shock resistant.
 - c. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified."
2. Ambient Temperature: 41 to 104 deg F.
3. Relative Humidity: Zero to 95 percent.

D. Luminaire Requirements

1. 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.
2. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place. Labels shall include but not limited to CCT, CRI and Lumens.
3. CRI of minimum 80. CCT of 3500K (interior). 4000K (exterior)
4. Related minimum luminaire life of 100,000 hrs to L70.
5. Luminaire dimmable from 100 percent to 10 percent of maximum light output unless otherwise specified on Luminaire Schedule.
6. All recessed fixtures less than 3" in diameter have accessibility to driver without reaching into ceiling cavity.
7. Lens:

- a. Acrylic diffusers: 100% virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- b. At least 0.125 inch minimum unless otherwise indicated on Luminaire schedule.
- 8. Housings: See luminaire schedule for exact requirements.
- 9. Recessed luminaires shall comply with NEMA LE 4.

E. Materials

- 1. Metal Parts:
 - a. Free of burrs and sharp corners and edges.
 - b. Sheet metal components shall be steel unless otherwise indicated.
 - c. Form and support to prevent warping and sagging.
- 2. Steel:
 - a. ASTM A36/A36M for carbon structural steel.
 - b. ASTM A568/A568M for sheet steel.
- 3. Stainless Steel:
 - a. Manufacturer's standard grade.
 - b. Manufacturer's standard type, ASTM A240/240M.
- 4. Galvanized Steel: ASTM A653/A653M.
- 5. Aluminum: ASTM B209.
- 6. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions.
- 7. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position

F. METAL FINISHES

- 1. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

3.2 EXAMINATION

- A. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. EC shall receive approval from engineer/lighting designer prior to luminaire installation when there is a layout change due to unforeseen conditions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 TEMPORARY LIGHTING

- A. If approved by the Architect, Engineer and Lighting Designer, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting.

3.4 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings, walls and finished grade unless otherwise indicated.
- C. Aim as indicated on Drawings.
- D. Install per manufacturer's installation instructions.
- E. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- F. Flush-Mounted Luminaires:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- G. Wall-Mounted Luminaires:
 - 1. Attached to structural members in walls
 - 2. Do not attach luminaires directly to gypsum board.
- H. Suspended Luminaires:
 - 1. Ceiling Mount:
 - a. Aircraft cable size and support locations per manufacturer's requirements. See drawings for exact length.
 - b. Aircraft cable supports and quantity per manufacturer's requirements. See drawings for exact length.
 - c. Hook mount.
 - 2. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing, rod, or wire support for suspension for each unit length of luminaire chassis, including one at each end.
 - 5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure. See seismic detail on drawings.

- I. Ceiling-Grid-Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
 - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.
- J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.5 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

- A. Aim as indicated on Drawings.
- B. Install on concrete base with top 4 inches above finished grade or as indicated on fixture details on drawings. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.6 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533.13 "Conduits for Electrical Systems." In concrete foundations, wrap conduit with pipe-wrapping plastic tape applied with a 50 percent overlap.

3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing luminaires, lighting controls, and accessories, and after electrical circuitry has been energized, test luminaires with controls to confirm proper operation. Any defective component in the lighting systems shall be replaced and the system reprogrammed if necessary.
 - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
 - 3. Illumination Tests:
 - a. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
 - 1) IES LM-5.
 - 2) IES LM-72.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.

3.8 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied

conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

END OF SECTION 26 51 00

SECTION 26 52 13 – EMERGENCY LIGHTING TRANSFER DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Emergency lighting transfer device (LTB)
 - 2. Lighting transfer switch (LTS)

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Not required.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 EMERGENCY LIGHTING TRANSFER DEVICE

- A. Lighting Transfer/Bypass Device (LTB) with Remote Test Button
 - 1. UL 924 listed.
 - 2. Contact ratings:
 - a. 20 amp magnetic ballast @ 277 Vac
 - b. 16 amp electronic ballast @ 277 Vac
 - 3. Bypasses local manual or automatic lighting controls so an emergency luminaire provides full brightness during a power outage. Normally downstream of a UL 1008 listed Automatic Transfer Switch (ATS) or Lighting Transfer Switch (LTS).
 - 4. Includes a dry contact to interrupt 0-10V dimming control circuit.

5. Includes remote test input to be used with Functional Devices Remote Test Button #ESRTB (or equivalent). Provide and install the Remote Test Button in an accessible location flush in the ceiling or above 80" AFF on wall or where indicated on the drawings.
6. Functional Devices Automatic Load Control Relay #ESRN or equivalent.

2.3 LIGHTING TRANSFER SWITCH (LTS)

- A. UL 1008 listed.
- B. Contact ratings:
 1. 20 amp lighting load @120-277 Vac
- C. Switches between a normal and emergency source/circuit.
- D. Includes a dry contact to interrupt 0-10V dimming control circuit.
- E. Myers Branch Circuit Emergency Lighting Transfer Switch #EPC-D-F-LS or equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

1. Install per manufacturer's recommendation.

3.2 FIELD QUALITY CONTROL

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

END OF SECTION 26 52 13

SECTION 27 05 28 – PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pathways
2. Hangers and supports
3. Conduit and bacboxes

A. Work Included:

1. Furnish material, labor and services necessary for, and incidental to, installing the following systems where shown on the Plans and as hereinafter specified. Include all necessary work in the related sections of the Specifications to provide for complete systems.

1.2 ACTION SUBMITTALS

- A. Not required

1.3 INFORMATIONAL SUBMITTALS

- A. Not required

1.4 CLOSEOUT SUBMITTALS

- A. Not required

1.5 REFERENCES, RELATED SECTIONS of the SPECIFICATIONS

A. Requirements of the following Sections of the Specifications apply to Work for this Section:

1. Division 26 – Electrical
2. Division 28 – Electronic Safety and Security

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

PART 3 - EXECUTION

3.1 PATHWAYS

- A. All cabling shall be as shown on plans, and per specifications.
- B. Cabling may be run as open-type plenum rated cable concealed above lay-in ceiling spaces. Non plenum rated cabling shall be installed in conduit. Cabling shall be installed in conduit in all exterior locations and in all exposed or inaccessible locations including all open to structure, cloud ceilings, inside wall partitions or above drywall, wood, and other inaccessible ceilings.
- C. Cabling may be run as open-type plenum rated cable concealed above lay-in ceiling space and exposed open to structure above or cloud type ceilings unless noted below. Cabling shall be installed above bar joist flanges to conceal cabling from view when routed through exposed ceiling. Non plenum rated cabling shall be installed in conduit. Cabling shall be installed in conduit in all exterior locations, all areas exposed below 8' A.F.F., and all inaccessible locations including inside wall partitions or above drywall, wood, and other inaccessible ceilings. Cabling shall be installed in conduit in the following spaces:
 - 1. Electrical, Mechanical Equipment Rooms
 - 2. Storage and Janitor Closets
 - 3. Blackbox Theater
 - 4. Scene Shop
 - 5. Multipurpose Room
 - 6. Classrooms
 - 7. Auditorium/Theater
 - 8. Stairwells
 - 9. Shell space
 - 10. Restrooms
 - 11. Tunnels
- D. Cables shall be continuous from outlet to termination equipment.
- E. Cables shall be terminated using tools recommended by the termination manufacturer.
- F. Provide 2" minimum sleeves in all walls which cable runs pass through.
- G. Furnish and install a minimum of (1) one cable pathway device through fire rated partitions and floors, and where indicated on the drawings. Device shall be Specified Technologies, Inc. EZDP33FWS, 3M QuickPass, or equivalent.
- H. Refer to 26 05 29 for fire sealing of penetrations through fire rated walls.
- I. Provide access panels as necessary for cable routing.

3.2 HANGERS AND SUPPORTS

- A. Cables shall be supported with “J-Hooks” a minimum of every four feet. Bridal rings can be used when supporting (other than Cat 6) a maximum of six wires. Support devices are to be attached to existing permanent structure.
- B. Cables shall be installed in cable tray where available.
- C. Cables and supports shall be installed at a readily accessible location above ceilings.

3.3 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

- A. Furnish and install conduit rough-ins at all outlets locations where shown on drawings. Rough-in shall consist of a two-gang outlet box, single gang trim ring, and a minimum 1” conduit stubbed above an accessible ceiling. Plastic bushings shall be installed on both ends of conduit. Install blank covers on all unused rough-ins.
- B. All conduits serving telephone/data communication outlets shall be 1” minimum. Conduits for all other system cable runs shall be sized for 40% maximum fill, or as shown on the drawings. Redundant paths shall be installed where fill exceeds 40%.
- C. Provide pull strings in all conduits.
- D. Conduit bends shall accommodate radius requirements of fiber cable as necessary.

END OF SECTION 27 05 28

SECTION 27 13 23 – COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Optical fiber backbone cable
 - 2. Buffer tube fanout kits
 - 3. Optical fiber connectors
 - 4. Fiber enclosures
- B. Work Included:
 - 1. Furnish material, labor and services necessary for, and incidental to, installing the following systems where shown on the Plans and as hereinafter specified. Include all necessary work in the related sections of the Specifications to provide for complete systems.

1.2 ACTION SUBMITTALS

- A. Product Data

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturers installation instructions

1.4 CLOSEOUT SUBMITTALS

- A. As-built drawings providing identification and routing of all fiber cabling.

1.5 REFERENCES, RELATED SECTIONS of the SPECIFICATIONS

- A. Requirements of the following Sections of the Specifications apply to Work for this Section:
 - 1. Division 26 – Electrical
 - 2. Division 28 – Electronic Safety and Security

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Commscope or equivalent

2.3 FIBER OPTIC CABLE SYSTEMS

- A. Where indicated on the drawing fiber shall be Commscope Arid-core 6-Strand Multi-mode #O-006-LA-6F-F-OR.
- B. Fiber cable shall be broken out into individual fibers by use of buffer tube fan-out kits and loose tube cable for furcation kits by Commscope.
- C. Each strand shall be terminated with a Uni-Cam SC type ceramic connector, #MFC-SCU-29 for multi-mode, at each end as manufactured by Commscope.
- D. Furnish and install Fiber Enclosures in the equipment racks in the telecom rooms as indicated on the drawings. Fiber Enclosures are to be Commscope #RFE-SLC-024-MFA-SC06

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Each strand shall be identified by a label at each end.
- B. Coordinate location of fiber enclosures within racks with Owner's Representative.
- C. All fibers shall be continuous, without splice, from end to end.

3.2 TESTING

- A. Testing shall be of the optical link. An optical fiber link is defined as the passive cabling network between two optical cross-connects (patch panels or outlets). This includes cable, connectors and splices but does not include active components. The link test contains the representative connector loss at the patch panel associated with the mating of patch cords but does not include the performance of the connector at the equipment interface. All cabling not tested strictly in accordance with these procedures shall be re-tested at no additional cost to the Owner. 100% of the installed cabling must be tested. All tests must pass acceptance criteria defined herein.
- B. Unless otherwise specified, multimode and single-mode fiber cable must meet the transmission performance parameters as specified in ANSI/TIA/EIA-568-B.3.
- C. Link attenuation shall be tested in accordance with ANSI/TIA/EIA-526-14A. Reference measurements shall be made in accordance with method B or equivalent. Optical loss shall be measured on each fiber at 850 nm and 1300 nm. Loss shall be measured on each fiber from each direction (bi-directionally), unless it is known in advance which fibers shall transmit (T_x) and receive (R_x).

- D. Link length shall be optically measured or calculated using cable sheath length markings.
- E. Cabling shall meet the following loss and length.
- | | |
|----------------------|---|
| Attenuation 850 nm: | \leq fiber length (km) x 3.75 dB/km
+ number connector pairs x 0.75 dB
+ number of splices x 0.3 dB |
| Attenuation 1300 nm: | \leq fiber length (km) x 1.5 dB/km
+ number connector pairs x 0.75 dB
+ number of splices x 0.3 dB |
| Length: | \leq 2000 m (6560 ft) |
- F. Test reports may be submitted in hardcopy and/or electronic format. Hand-written test reports are not acceptable.
- G. Hardcopy reports are to be submitted in labeled 3 ring binders with a witness signature verifying passing execution of all tests.
- H. Electronic reports are to be submitted on 3.5 inch diskettes or CD format. Disk or CD shall contain the software required to view test results. Electronic reports must be accompanied by a Certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report. Certificate must reference traceable circuit numbers that match the electronic record.
- I. Test reports shall include the following information for each cabling element tested:
1. Actual measured and maximum allowable attenuation (loss) at the specified wavelengths and the margin. An individual test that fails the link criteria shall be marked as FAIL.
 2. Reference method.
 3. Number of mated connectors and number of splices (if any).
 4. Actual length and maximum allowable length per Part 2 Section 3. Any individual test that fails the link length criteria shall be marked as FAIL.
 5. Group refractive index (GRI) for the type of fiber tested, if length was optically measured.
 6. Tester manufacturer, model, serial number and software version.
 7. Circuit ID number and project/job name.
 8. Link criteria (Autotest) used.
 9. Overall pass/fail indication.
 10. Date and time of test.
- J. Test reports shall be submitted within 7 business days of completion of testing.
- K. Test equipment used under this contract shall be from manufacturers that have a minimum of 5 years experience in producing field test equipment. Manufacturers must be ISO 9001 certified. All test tools of a given type shall be from the same manufacturer, and have compatible electronic results output.
- L. Test equipment shall be capable of measuring relative or absolute optical power in accordance with TIA/EIA-526-14A, "Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant," and TIA/EIA-526-7 method A, "Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Insertion Loss Using An Optical Power Meter."

- M. Test equipment shall not include the loss or length of the test jumpers in the cable plant measurements.
- N. Multimode test equipment shall incorporate both 850 nm and 1300 nm sources in same unit. The coupled output power into multimode fiber shall be ≥ -20 dBm at each wavelength. Detectors shall have a dynamic range of at least +3 dB to -55 dB.
- O. Sources and meters shall automatically synchronize wavelengths to prevent calibration-related errors.
- P. The time-of-flight methodology shall be employed when optically measuring fiber length.
- Q. Test equipment capable of measuring a Tx/Rx fiber pair simultaneously is recommended to enhance productivity.
- R. Contractor must warrant in writing that 100% of the installation meets the requirements specified above.
- S. Owner reserves the right to conduct, using Contractor equipment and labor, a random re-test of up to five (5) percent of the cable plant to confirm documented results. Any failing cabling shall be re-tested and restored to a passing condition. In the event more than two (2) percent of the cable plant fails during re-test, the entire cable plant shall be re-tested and restored to a passing condition at no additional cost to the Owner.
- T. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation as described in Part 2, section 4.
- U. Contractor shall warrant Installation against all product defects, and that all approved cabling components meet or exceed the requirements of this document.

END OF SECTION 27 13 23

SECTION 27 15 13 – COMMUNICATIONS COPPER HORIZONTAL CABLING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper horizontal cable
2. Modular jacks and faceplates
3. Terminal blocks and patch panels
4. Equipment racks

B. Work Included:

1. The Electrical Contractor shall furnish and install all materials, accessories, and labor required to install a new telephone and/or data cabling system or an operational extension of the existing telephone and/or data cabling system.
2. The Contractor shall be trained and certified by the equipment manufacturer.
3. The Contractor shall attend coordination meetings with the Owner and Engineer prior to installation.

1.2 ACTION SUBMITTALS

A. Product Data

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers installation instructions

1.4 CLOSEOUT SUBMITTALS

A. Provide as-built drawings indicating cable routing and cable/jack/patch panel identification.

1.5 REFERENCES, RELATED SECTIONS of the SPECIFICATIONS

A. Requirements of the following Sections of the Specifications apply to Work for this Section:

1. Division 26 – Electrical
2. Division 28 – Electronic Safety and Security

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Homaco
- B. Panduit
- C. Hoffman

2.3 CABLING

- A. One Four-pair category 6 23 gauge MPP/CMP plenum rated 100 ohm UTP cables to be designated as station voice to be wired at wall outlet on (UNJ600-BK) modules using T568B wiring scheme termination at wall outlet per manufactures specification and at the closet end on patch panels (part #UNP610-24P) using the T568B wiring scheme. These cables shall be designated as V1 along with the outlet number assigned. Place the ivory voice icon (UNJ-ICON-IV) in the designated area on jack.
- B. One Four-pair category 6, 23 gauge MPP/CMP plenum rated UTP cables to be designated as station network to be wired at wall outlet on (UNJ600-BK) modules using T568B wiring scheme termination at wall outlet per manufactures specification and at the closet end on patch panels (part #UNP610-24P) using the T568B wiring scheme. These cables shall be designated as N1 along with the outlet number assigned. Place the ivory data icon (UNJ-ICON-IV) in designated area on jack.
- C. Cable jacket color shall be in accordance with the building standards.
- D. Cables shall not exceed 90 meters from termination location to wall outlet.

2.4 TELEPHONE/DATA CABLING SYSTEMS EQUIPMENT

- A. Furnish and install faceplate and modular jacks at each Voice/Data outlet as described below:
 - 1. One Panduit single gang Sloped Modular Flush-Mount Faceplate (part #CFPSL4EIY).
 - 2. One Panduit Mini-Com modular jack to be designated as stations Voice (part #CJ688TGEI).
 - 3. Two Pandit Mini-Com modular jacks to be designated as stations Network (part #CJ688TGBU).
 - 4. Furnish, install and terminate one Voice, and two Network cable for each outlet.
- B. Furnish and install faceplate and modular jacks at each Voice outlet as described below:
 - 1. One Panduit single gang Sloped Modular Flush-Mount Faceplate (part #CFPSL2EIY).

2. One Panduit Mini-Com modular jack to be designated as stations Voice (part #CJ688TGEI).
 3. Furnish, install and terminate one Voice cable for each outlet.
- C. Furnish and install faceplate and modular jacks at each Data outlet as described below:
1. One Panduit single gang Sloped Modular Flush-Mount Faceplate (part #CFPSL2EIY).
 2. Two Panduit Mini-Com modular jacks to be designated as stations Network (part #CJ688TGEI).
 3. Furnish, install and terminate two Network cables for each outlet.
- D. Furnish and install faceplate and modular jacks at each Non-Standard Voice/Data outlet as describe below:
1. One Panduit Sloped Modular Flush-Mount Faceplate in size as required to accommodate number of terminations.
 2. Panduit Mini-Com modular jacks to be designated as stations Network (part #CJ688TGEI) in quantity as indicated on the drawings.
 3. Furnish, install and terminate Network cables for each outlet.
 4. One Panduit Mini-Com modular jack to be designated as stations Voice (part #CJ688TGEI) in quantity as indicated on the drawings.
 5. Furnish, install and terminate Voice cables for each outlet.
- E. Furnish and install Commscope terminal blocks on designated wall in Telecommunications Room for termination of voice cables. Terminate voice cabling with sufficient slack to allow for future relocation to a patch panel in the network rack. Furnish and install 19" racks, patch panels and horizontal management for termination of network cables and fiber.
1. Provide Panduit (part #UICMPPK6G24BL) category six patch panels for network terminations.
 2. Provide and install Panduit (part #CMR19x84 or equivalent by Homaco) equipment racks in quantity and locations as follows:
 - a. (2) Equipment Racks in Art Annex Second Floor IT Room
 3. Each rack shall have Panduit vertical cable management (Part #WMPV45E) mounted on each side, and Panduit horizontal cable management (Part #WMP1E) mounted between each switch or patch panel. Provide and install a minimum of two Leviton (part # 5500-192) 19" rack mount power strips with surge suppression for power to the electronic equipment.
 4. Note: All cables routed from Telecommunications Room out to wall outlets shall be routed within Telecommunication Room to equipment racks on ladder racking or cable runway, this shall be furnished and installed in a Black Finish. The equipment racks have a 12" ladder channel on top to accept runway. Junction Splices, Butt-splices, Radius drop kits, wall angles, rack to runway mounting plates, and corner support brackets shall be furnished in quantities required for proper installation.
- F. Labeling and Standards
1. Cables at wall outlets and terminations at communication closet shall be identified and labeled as follows, depending on typical vs non typical.
 - Typical
 - V1 - first telephone (or voice) cable at a given outlet.
 - N1 - first network cable at a given outlet
 2. The first location shall start with the number (1) and continue, labels at wall outlet shall be TIA/EIA-606 Compliant

3. All of work described above shall be ANSI/TIA/EIA-568B.1, B.2, B.3-1 & 569B compliant and follow NEC codes local or otherwise.
 4. All voice and network terminations at communication closet shall be terminated on patch panels and 19" racks permanently mounted on floor of Telecommunication Room. Cables shall be terminated in distinct and separate panels for each type; voice, building network, and research network.
- G. Voice cable shall be Panduit (#PUP6004WH-U White) Plenum. Network cable shall be Panduit (#PUP6004BU-U Blue) Plenum. No equivalents accepted. All of the above mentioned equipment and scope of work shall be properly grounded and bonded per TIA/EIA-607.
- H. Provide 10- Commscope (#UNC6-XX-10F-B) and 20- Commscope (#UNC6-XX-5F-B) Modular Interface patch Cords for use in Telecommunications Room and at work outlet for Network.

PART 3 - EXECUTION

3.1 ROUGH-INS

- A. Furnish and install rough-ins where shown on drawings. Rough-in shall consist of a two-gang outlet box, single gang trim ring, and a minimum 1" conduit stubbed above an accessible ceiling. Install blank covers on all unused rough-ins.
- B. Maximum fill of conduit is not to exceed forty percent.
- C. Furnish and install minimum 2" sleeve through fire rated partitions.
- D. Refer to 26 05 29 for fire sealing of penetrations through fire rated walls.

3.2 Testing and Labeling

- A. Field test data cables after installation for acceptance as defined in ANSI/TIA-1152 (and/or IEC 61935-1). Acceptance tests to include continuity, length, attenuation, crosstalk, and noise. The results of all tests for each cable will be documented in a printout from the test instrument and provided to the owner. Any cables which fail will be corrected and re-tested with the new test results provided to owner.
- B. Label jacks at outlet faceplates and patch panels and label cables at the outlets and other termination location in accordance with the building standards.
- C. Provide colored cables and jacks in accordance with the building standards.

END OF SECTION 27 15 13

SECTION 27 15 33 – COMMUNICATIONS COAXIAL HORIZONTAL CABLING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Outlets and faceplates
 - 2. Splitters
- B. Work Included:
 - 1. Furnish material, labor and services necessary for, and incidental to, installing the following systems where shown on the Plans and as hereinafter specified. Include all necessary work in the related sections of the Specifications to provide for complete systems.

1.2 ACTION SUBMITTALS

- A. Product Data

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturers installation instructions

1.4 CLOSEOUT SUBMITTALS

- A. As-built drawings

1.5 REFERENCES, RELATED SECTIONS of the SPECIFICATIONS

- A. Requirements of the following Sections of the Specifications apply to Work for this Section:
 - 1. Division 26 – Electrical
 - 2. Division 28 – Electronic Safety and Security

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 PRODUCTS

- A. RG-6/U Coaxial Cable
- B. Coaxial F Connectors
- C. 8 Port Splitters

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Furnish and install cable television system rough ins where shown on drawings. Rough in shall consist of a two gang outlet box, single gang trim ring, and a 1" conduit stubbed above an accessible ceiling. Install blank covers on all unused rough ins.
- B. Install one RG-6/U plenum rated coaxial cable from each TV outlet to the telephone board in Data 059. Provide a minimum of 12" of slack at each outlet and five feet at the telephone boards.
- C. Where not within a raceway, cable shall be installed in D-rings with five-foot spacing. D-rings shall be attached to the structure. Label all cables at each end.
- D. TV outlets shall consist of a female type 'F' connector with an ivory faceplate.
- E. Provide 8 port splitters at the telephone board(s) in sufficient quantity to terminate all cables or as shown on the drawings.
- F. Provide as-built drawings providing identification and routing of all cables.

END OF SECTION 27 15 33

SECTION 27 41 00 – AUDIO-VIDEO SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This project is for the construction of a new construction Art Annex Building and limited renovation scope in Craig Hall. The design, defined by the Project Documents, provides for the installation, programming and testing, and owner training of the Audio-Visual systems.

1.2 DEFINITIONS

- A. RGB: Red, Green, Blue
- B. RGBS: Red, Green, Blue, Sync
- C. RGBHV: Red, Green, Blue, Horizontal Sync, Vertical Sync
- D. Y-C: Chrominance, Luminance
- E. S-Video: Chrominance, Luminance
- F. DVI = Digital Video Interface
- G. HDMI = High Definition Media Interface
- H. SDI = Serial Digital Interface
- I. HDSDI = High Definition Serial Digital Interface

1.3 SYSTEM DESCRIPTIONS

- A. Blackbox Theater
 - 1. Sixteen (16) channels of wireless microphones shall be provided with combined true diversity distributed antennae. The provided transmitters shall be a combination of bodypack with lapel and handheld units.
 - 2. A flexible audio signal processor with network audio support integrated into the system for loudspeaker signal processing requirements, limiting and protection circuits, signal distribution, interface with AV control system and automated controls, and miscellaneous feeds such as media outputs and overflow spaces. Dante digital audio bus included with

audio processor allowing the system to add additional inputs and outputs as required to accommodate future changes or additions.

3. The sound reinforcement system for the Blackbox house will produce high-quality sound for speech and music for multiple seating arrangements. The speakers will consist of powered two-way speakers with low-frequency subwoofers with mounting brackets and pipe clamp accessories to allow speakers to be easily moved and repositioned in the ceiling grid as required with centrally located connectivity plate and distributed AC power receptacles. Overflow audio shall be provided to dressing rooms, MFD Studio above, and Lobby.
4. Two-channel production intercom system included with wireless intercom base units, wireless intercom beltpacks and headsets, wired intercom beltpacks and jacks. Intercom speaker stations shall be included in the dressing rooms and MFD Studio directly above the Black Box.
5. Input/output plates will be located throughout the perimeter of the lower and upper accessible area that will provide microphone inputs, tie lines, monitor speakers (line-level for powered units), HDMI video and AV and network data. The mixing console system shall have support for mobile app to allow the sound operator to roam and listen throughout the Black Box while making adjustments.
6. Low light camera shall be provided to send low-latency feed to monitor locations in the control booth, dressing rooms, and MFD Studio above.
7. A single-chip, laser-phosphor DLP projector with 1080p resolution and 10,000 (min) lumens will be provided with motorized drop-down tensioned projection screen.
8. Stage Manager's location will include a paging microphone for backstage areas. Additional AV inputs and AV touch panel installed in the control room to allow integrated control of system power, AV source selection and volume control and video mute.
9. An equipment cabinet will be included to house all AV equipment and will be located near the control booth.

B. Lobby

1. Distributed audio shall produce high-quality sound for background music and overflow audio from the Black Box. Head-end equipment for input and amplification shall be located in the Blackbox control booth. Local microphone and control plates located in the Lobby, allowing the Lobby to function independently of the Blackbox.
2. Digital signage display with media player shall be provided.

C. MFD Rehearsal Studios

1. Larger studio shall have four (4) channels of wireless microphones shall be provided. Three bodypack transmitters with lapel and headset microphones (one and two respectively) and one handheld microphone transmitter.
2. The sound reinforcement system will produce high-quality sound for speech and music. Distributed subwoofers shall be provided to extend the low frequency performance of the space.
3. A flexible audio signal processor with network audio support integrated into the system for loudspeaker signal processing requirements, limiting and protection circuits, signal distribution, and interface with AV control system. Dante digital audio bus included with audio processor allowing the system to add additional inputs and outputs as required to accommodate future changes or additions.
4. A single-chip, laser-phosphor DLP projector with 1080p resolution and 7,500 (min) lumens will be provided with motorized drop-down tensioned projection screen.
5. A user interface location will provide the following:
 - Wall plate in one location will provide HDMI and Bluetooth inputs.
 - Touch panel for system on/off, source select, and level control.
6. A single rack location on the second level shall be a shared head-end for all studios.

D. Acting Studios

1. Larger studio shall have four (4) channels of wireless microphones shall be provided. Three bodypack transmitters with lapel and headset microphones (one and two respectively) and one handheld microphone transmitter.
2. The sound reinforcement system will produce high-quality sound for speech and music. The speakers shall be integrated into the ceiling system to leave the walls open for flexibility.
3. A flexible audio signal processor with network audio support integrated into the system for loudspeaker signal processing requirements, limiting and protection circuits, signal distribution, and interface with AV control system. Dante digital audio bus included with audio processor allowing the system to add additional inputs and outputs as required to accommodate future changes or additions.
4. A single-chip, laser-phosphor DLP projector with 1080p resolution and 7,500 (min) lumens will be provided with motorized drop-down tensioned projection screen.
5. A user interface location will provide the following:
 - Wall plate in one location will provide HDMI and Bluetooth inputs.
 - Touch panel for system on/off, source select, and level control.

E. DTMS Design Class

1. The sound reinforcement system will produce high-quality sound for speech and music.
2. A flexible audio signal processor with network audio support integrated into the system for loudspeaker signal processing requirements, limiting and protection circuits, signal distribution, and interface with AV control system. Dante digital audio bus included with audio processor allowing the system to add additional inputs and outputs as required to accommodate future changes or additions.
3. Two 75" flat panel monitors will be provided with duplicate content.
4. A user interface location will provide the following:
 - Wall plate in one location will provide HDMI and Bluetooth inputs.
 - Touch panel for system on/off, source select, and level control.

F. Acting Studio/Classroom 206 (Craig Hall)

1. Four (4) channels of wireless microphones shall be provided. Provide two bodypacks with lapels and two handheld microphone transmitters.
2. The sound reinforcement system will produce high-quality sound for speech and music. The speakers shall include high-quality two-way units with low-frequency subwoofer.
3. A flexible audio signal processor with network audio support integrated into the system for loudspeaker signal processing requirements, limiting and protection circuits, signal distribution, and interface with AV control system. Dante digital audio bus included with audio processor allowing the system to add additional inputs and outputs as required to accommodate future changes or additions.
4. A single-chip, laser-phosphor DLP projector with 1080p resolution and 7,500 (min) lumens will be provided with motorized drop-down tensioned projection screen.
5. A high definition motorized PTZ camera shall be provided to capture the room for remote viewing via soft-codec (Zoom). Camera signal shall return to user interface location with ability to connect USB to a BYOD computer. Microphone mixed audio signal shall be included in signal chain for remote viewing.
6. A user interface location will provide the following:
 - Wall plate in one location will provide HDMI and Bluetooth inputs.
 - Touch panel for system on/off, source select, and level control of all sources.
 - Connectivity to camera and audio for soft-codec (Zoom).

1.4 SUBMITTALS

- A. Prior to shop drawing submittal, contractor will submit touch screen sheet layouts to the owner for review. Programming allowance shall be made to modify touch screen pages without additional compensation.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: Shop drawings and submittal data shall contain sufficient information to describe the work to be performed. Prepare drawings at an appropriate scale and submit the required number of copies (see Division 1) of the submittal package neatly bound in sets. The required information shall include but not be limited to:
 - 1. Detail equipment assemblies and indicate dimensions, weights, required clearances.
 - 2. Written verification of the Audio-Visual Contractor's qualifications as required in this section.
 - 3. Wiring diagrams for each system including wire types.
 - 4. Rack drawings showing proposed rack layout.
 - 5. Speaker mounting details. (Note: It is the responsibility of the Audio-Visual Contractor to assure the structural integrity of the speaker hanging method and hardware only.)
 - 6. All rough-in information including junction and back boxes.
 - 7. Layout of all custom plates outlet plates/panels.
 - 8. A material list of all equipment to be furnished.
 - 9. Manufacturers specification sheets of all equipment to be provided. (bound in a neat and orderly fashion with an index listing the manufacturer's specification sheets in specification order).
- D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.
- E. Operation and Maintenance Data

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: The Audio-Visual Systems Contractor shall be a contractor who has been continuously engaged in furnishing and installing commercial audio and video systems of the type specified for at least five (5) years.
- B. The Audio-Visual Systems Contractor shall maintain a suitably staffed and equipped service organization and shall regularly offer maintenance services for systems of this type and size.
- C. The Audio-Visual Systems Contractor shall be an authorized dealer of all equipment provided with this system. Given the inherent warrantee difficulties which occur when products are provided from contractors who participate in trans-shipping or two-stepped equipment sales, this dealership requirement will be strictly adhered to. At the owner's request, any contractor responding to this bid proposal must provide proof of dealership status for all listed system components or approved alternates. Failure to comply with this request will be grounds for bid rejection.

- D. At the request of the Owner, Architect or Engineer, an inspection of the Audio-Visual Systems Contractor's place of business shall be scheduled to demonstrate that the contractor possesses adequate plant and equipment to complete the work properly and in a timely manner, adequate staff with sufficient technical experience, and suitable financial status to meet the obligations of the contract.
- E. The Audio-Visual Systems Contractor shall supply technicians who have received training from a nationally recognized training organization in the last 5 years on "speaker rigging methods" and "rigging safety".
- F. An Electrical Contractor who does not meet the requirements listed above who intends to bid on this work shall be required to employ the services of a qualified Audio-Visual Systems Sub-Contractor. The Audio-Visual Systems Contractor must be named in the shop drawing submittal information along with written documentation verifying that the sub-contractor fulfills all requirements listed in 119690.

1.6 COORDINATION

- A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Refer to the Audio-Visual Drawings for all required equipment.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used]. Conceal raceway and cables except in unfinished spaces.
- B. Install plenum cable in environmental air spaces, including plenum ceilings.
- C. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
- D. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

- E. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF RACEWAYS

- A. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
- B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.3 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Cable Installation Requirements: All work shall be performed under the supervision of a Audio-Visual equipment supplier accredited by the factory of the system manufacturer. Satisfactory performance of the equipment shall be the responsibility of the equipment supplier. The final connections and shall be by the Audio-Visual Systems Contractor.
 - 1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
 - 2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
 - 3. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
 - 5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 6. Precautions shall be taken to prevent electromagnetic and electrostatic hum pickup in the system wiring. For line level audio signals, float cable shields at the output of the source device. Shields not connected are to be folded back over the cable jacket and covered with heat shrink tubing for future use. Do not cut off unused shields.
 - 7. Furnish and install minimum (1) one cable penetration EZDP33FWS, as manufactured by Specified Technologies, Inc. or equivalent, through fire rated partitions and floors, as indicated on the drawings.
- C. Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides in equipment room spaces with terminating hardware and interconnection equipment.
 - 2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.
 - 3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

- D. Separation of Wires: Separate speaker level, line-level, microphone-level, control, video and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate parallel audio-visual system conductors from power runs by at least 12 inches. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.4 INSTALLATION

- A. Bridged connections should be applied at microphone and line-level signal interfaces to maximize voltage transfer.
- B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
- C. Mount equipment and enclosures plumb and square. Permanently installed equipment to be firmly and safely held in place, with extra safety cable used where possible. Design equipment supports with a minimum safety factor of five for any overhead loudspeakers. Provide speaker mounting hardware with $\pm 5^\circ$ adjustability from the specified aiming angle and perform such adjustments upon request without claim for additional payment.
- D. Metallic speaker back boxes will be required on all ceiling or wall mount flush speakers.
- E. Each cable shall be properly identified at each end using suitable wrap-around or other permanent labeling method. All cable numbers shall be marked on the record drawings for future reference.
- F. Equipment Cabinets and Racks:
 - 1. Group items of same function together and arrange controls symmetrically.
 - 2. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
 - 3. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.
 - 4. Provide engraved lamacoid or adhesive backed laminated labels on the front and rear of all active equipment mounted in the racks. Hand-written or embossed "ROTEX" or "DYMO" type labels shall not be accepted. Mark controls for easy operation by an operator unfamiliar with the system.
- G. Limiter/Compressor: Program digital signal processors serving each speaker output with a limiter/compressor to avoid damage to speakers from system overloads.
- H. Wall-Mounted Outlets: Flush mounted.
- I. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.
- J. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

3.5 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Terminate equipment racks and other audio-visual equipment with properly grounded receptacles (no isolated grounds).

3.6 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Schedule tests with at least seven days' advance notice of test performance.
 - 2. After installing the Audio-Visual systems, test for compliance with requirements.
 - 3. Operational Test: Perform tests that include originating program at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
 - 4. Acoustic Coverage Test: Measure system response to ensure variation of sound pressure levels in audience areas is plus or minus 2 dB.
- B. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified

3.7 DEMONSTRATION

- A. Owner's operating personnel in the proper set up, operating and maintenance procedures, installed under this contract, and shall include at least three (3) service calls of 4 hours minimum during the warranty period for service or instructions as required by the Owner, at a time mutually agreeable to the Owner and Contractor.
- B. Provide minimum of two four-hour training sessions for system operation of the Blackbox Theater and two one-hour sessions for all other Audio-Visual systems.

END OF SECTION 27 41 00

SECTION 27 53 13 – CLOCK AND TIME TONE SYSTEM

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS & SCOPE

- A. Furnish and install a complete new wireless clock and time tone distribution/paging system.
- B. All bids shall be based on the equipment as specified herein. The catalog numbers and model designations are that of Sapling, Inc, Dukane, Peavey and Lowell. The specifying authority must approve any alternate system.

1.2 SUMMARY

- A. This Section addresses the needs and requirements of the wireless clock system. It includes requirements for the wireless clock system components including, but not limited to, the following:
 - 1. Wireless Transceiver
 - 2. Wireless Repeater
 - 3. Secondary Analog Clock
 - 4. Time tone/paging system

1.3 SYSTEM DESCRIPTION

- A. General: Furnish and install all equipment, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating system.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract Sections:
 - 1. Submit equipment prints, full electronic wiring diagrams and specifications sheets for each item specified herein. Provide a tabulation of the specification clearly comparing the submitted item with the specified item, being able to refer to all written expressed functions and capabilities. Specification sheets shall be submitted on all items.
 - 2. Shop drawings detailing wireless clock
 - 3. Wiring diagrams, detailing wiring for power, signal, and control.
 - 4. Submit wiring diagrams showing typical connections for all equipment.
 - 5. Submit a certificate of completion of installation and service training.

1.5 QUALITY ASSURANCE

- A. All items of equipment shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.

- B. The contractor shall be an established communications and electronics contractor that has had and currently maintains a locally run and operated business for at least three (3) years. The contractor shall utilize a duly authorized distributor of the equipment supplied for this project location with full manufacturer's warranty privileges.
- C. The contractor shall show satisfactory evidence, upon request, that the supplier maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The supplier shall maintain at his facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.
- D. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code" including, but not limited to:
 - 1. Article 250, Grounding.
 - 2. Article 300, Part A. Wiring Method.
 - 3. Article 310, Conductors for General Wiring.
 - 4. Article 725, Remote Control, Signaling Circuits.
 - 5. Article 800, Communication Systems.
- E. Installation and start up of all systems shall be under the direct supervision of a local agency regularly engaged in installation, repair, and maintenance of such systems. The supplier shall be accredited by the proposed equipment manufacturers.
- F. The agency providing equipment shall be responsible for providing all specified equipment and mentioned services for all equipment as specified herein. The agency must be a local authorized distributor of all specified equipment for single source of responsibility and shall provide documents proving such. The agency must provide written proof that the agency is adequately staffed with factory-trained technicians for all of the specified equipment. The agency must have established business for and currently be providing all services for the equipment.
- G. The contractor shall guarantee availability of local service by factory-trained personnel of all specified equipment from an authorized distributor of all equipment specified under this section. Maintenance shall be provided at no cost to the purchaser for a period of one (1) year (parts and labor) from date of acceptance unless damage or failure is caused by misuse, abuse, neglect, or accident.
- H. The contractor is responsible for all cost associated with proper installation, termination, configuration, programming, impedance and load matching of all system components.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in factory boxes. Store in clean, dry space in original boxes. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

1.7 IN-SERVICE TRAINING

- A. The contractor shall provide training with this system. These sessions shall be broken into segments that will facilitate the training of individuals in the operation of this system. Operators Manuals and Users Guides shall be provided at the time of this training.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The manufacturer shall be:
 - 1. Sapling, Inc.
 - 2. Dukane Corporation
 - 3. Primex
 - 4. American Time
- B. The intent of this specification is to establish a standard of quality, function and features. It is the responsibility of the bidder to insure that the proposed product meets or exceeds every standard set forth in these specifications.
- C. The functions and features specified are vital to the operation of this facility, therefore, the acceptance of alternate manufacturers does not release the contractor from strict compliance with the requirements of this specification.
- D. The contractor shall be responsible for providing a complete functional system including all necessary components whether included in this specification or not.

2.2 SYSTEM

- A. The system shall have interface capability to GPS for time keeping stability.
- B. The system shall be capable of working in 915-928 MHz frequency-hopping technology. The system shall be capable of automatic transmission of data along 51 alternating frequencies that allows for an enhanced signal, even if there is interference in one of the frequencies.
- C. Each clock in the system shall be capable of receiving and transmitting the wireless signal which allows it to be used as a repeater while boosting the data stream and sending along the system. With this dual capability there shall be no limit on the number of clocks that can be used in the installation. The clock shall be designed to automatically work together without interference with each other. The system shall be capable of increasing the quality of the signal while increasing the quantity of the clocks.
- D. The system shall include a master clock time tone system, tone generator and amplifier to send time tone signals to the speakers for class change.
- E. The digital clock shall include automatic digital calibration for time base to minimize deviation from each other.
- F. The analog clock shall have the capability for diagnostic function that will allow the user to view the quality of the signal, how long since the last time the clock received a signal, as well as functional tests of the electronics and the gears.
- G. The system shall operate in a license-free frequency range where no license is required.

2.3 FCC APPROVAL

- A. This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a commercial installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
1. Reorient or relocate the receiving antenna.
 2. Increase the separation between the equipment and receiver.
 3. Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.
 4. Consult the dealer or an experienced radio/TV technician.

2.4 PRODUCT

- A. Head end Clock Equipment
1. The wireless repeater transmitter shall be the Sapling STR 100-056-1. The repeater transmitter shall send correction signals to the SAL wireless analog clocks. The repeater transmitter shall utilize 915–928 MHz frequency–hopping technology and shall be FCC compliant, part 15 Section 15,247. The repeater transmitter shall receive a correction signal from a Sapling GPS-400-000-1 GPS clock receiver for constant time accuracy. Provide an RS-485 connected time tone master, Sapling model SMC200-00S-1 for time tone distribution signal control.
 2. The supplied GPS antenna shall be mounted on the roof of the building. Provide roof penetrations and cable raceway to the headend location. The cable distance cannot exceed 75 feet in length.
- B. Digital Clocks
1. The secondary clock shall be Sapling SBL Series wireless clock. The clock will be capable of receiving a signal from multiple clocks. The clock shall receive and transmit with 915–928 MHz frequency–hopping technology. The clock is to be capable of transmitting the time simultaneously without interfering with each other. The clocks shall include automatic calibration, as well as a diagnostic function that allows the user to view the quality of the signal, the last time the clock received a correction signal, a gearbox test and a comprehensive analysis of the entire clock. The clock shall have a maximum correction time of five (5) minutes. It shall be designed to be used with the Sapling Transceiver or the Sapling Repeater, which can be regulated via Sapling wireless communication protocol. Upon receipt of the wireless signal, the clock will immediately self–correct. The clock shall have a semi–flush smooth surface ABS case. Glass and visible molding marks are unacceptable. The clock shall have red numeral display. The clock shall be FCC compliant, part 15 Section 15,247. Provide Sapling SBL-103-254-1R, 2.5 inch digital clocks in general areas, SBL-103-404-1R, 4 inch high digital clocks with SBD-004-404-1 Surface Housing and wire guards in gymnasiums, and SBL-103-404-1R, 4 inch high digital clocks in Cafeteria and Media Center. 120 volt power shall be provided for the all clocks.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install system in accordance with applicable codes. Install equipment in accordance with manufacturer's written instructions.

B. Wiring Methods:

1. Conceal wiring except in unfinished spaces.
2. All new wiring on this project must be properly rated for the application.
3. Cable to the new devices at new locations shall be installed in a neat and workmanlike manner, following the standard procedures used in the electrical contracting trade.
4. Exposed wiring will not be permitted under any circumstances on this project.
5. Any wiring, which is considered sloppy by the Engineer, shall be strictly unacceptable.
6. Upon installation completion, a room-by-room test shall be conducted for every device in the system. A technician shall perform the test after school hours, and repairs shall be performed as needed at no cost to the Owner to any devices, which do not function correctly, including cable. A written room-by-room report following testing and repairs shall be prepared and submitted to the Engineer.

3.2 FIELD QUALITY CONTROL

A. Contractor Field Service:

1. Provide services of a service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

B. Inspection:

1. Make observations to verify that units and controls are properly labeled.

C. Testing:

1. Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at the Contractor's expense. Verify by the system test that the total system meets the specifications and complies with applicable standards.

3.3 COMMISSIONING

- A. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Operators Manuals and Users Guides shall be provided at the time of this training.

- B. Schedule training with Owner through the Architect, with at least seven (7) days advance notice.

3.4 CLEANING AND PROTECTION

- A. Prior to final acceptance, clean system components and protect from damage and deterioration.

END OF SECTION 27 53 13

SECTION 28 05 28 – PATHWAYS FOR ELECTRONIC AND SAFETY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pathways
 - 2. Hangers and supports
 - 3. Conduit and backboxes
- A. Work Included:
 - 1. Furnish material, labor and services necessary for, and incidental to, installing the following systems where shown on the Plans and as hereinafter specified. Include all necessary work in the related sections of the Specifications to provide for complete systems.

1.2 ACTION SUBMITTALS

- A. Not required

1.3 INFORMATIONAL SUBMITTALS

- A. Not required

1.4 CLOSEOUT SUBMITTALS

- A. Not required

1.5 REFERENCES, RELATED SECTIONS of the SPECIFICATIONS

- A. Requirements of the following Sections of the Specifications apply to Work for this Section:
 - 1. Division 26 – Electrical
 - 2. Division 28 – Electronic Safety and Security

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

PART 3 - EXECUTION

3.1 PATHWAYS

- A. All cabling shall be as shown on plans, and per specifications.
- B. Cabling may be run as open-type plenum rated cable concealed above lay-in ceiling spaces. Non plenum rated cabling shall be installed in conduit. Cabling shall be installed in conduit in all exterior locations and in all exposed or inaccessible locations including all open to structure, cloud ceilings, inside wall partitions or above drywall, wood, and other inaccessible ceilings.
- C. Cabling may be run as open-type plenum rated cable concealed above lay-in ceiling space and exposed open to structure above or cloud type ceilings unless noted below. Cabling shall be installed above bar joist flanges to conceal cabling from view when routed through exposed ceiling. Non plenum rated cabling shall be installed in conduit. Cabling shall be installed in conduit in all exterior locations, all areas exposed below 8' A.F.F., and all inaccessible locations including inside wall partitions or above drywall, wood, and other inaccessible ceilings. Cabling shall be installed in conduit in the following spaces:
 - 1. Electrical, Mechanical Equipment Rooms
 - 2. Storage and Janitor Closets
 - 3. Gymnasium
 - 4. Natatorium
 - 5. Multipurpose Room
 - 6. Exercise Room
 - 7. Auditorium/Theater
 - 8. Stairwells
 - 9. Shell space
 - 10. Restrooms
 - 11. Tunnels
- D. Cables shall be continuous from outlet to termination equipment.
- E. Cables shall be terminated using tools recommended by the termination manufacturer.
- F. Provide 2" minimum sleeves in all walls which cable runs pass through.
- G. Furnish and install a minimum of (1) one cable pathway device through fire rated partitions and floors, and where indicated on the drawings. Device shall be Specified Technologies, Inc. EZDP33FWS, 3M QuickPass, or equivalent.
- H. Refer to 26 05 29 for fire sealing of penetrations through fire rated walls.
- I. Provide access panels as necessary for cable routing.

3.2 HANGERS AND SUPPORTS

- A. Cables shall be supported with “J-Hooks” a minimum of every four feet. Bridal rings can be used when supporting (other than Cat 6) a maximum of six wires. Support devices are to be attached to existing permanent structure.
- B. Cables shall be installed in cable tray where available.
- C. Cables and supports shall be installed at a readily accessible location above ceilings.

3.3 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

- A. Furnish and install conduit rough-ins at all outlets locations where shown on drawings. Rough-in shall consist of a two-gang outlet box, single gang trim ring, and a minimum 1” conduit stubbed above an accessible ceiling. Plastic bushings shall be installed on both ends of conduit. Install blank covers on all unused rough-ins.
- B. All conduits serving telephone/data communication outlets shall be 1” minimum. Conduits for all other system cable runs shall be sized for 40% maximum fill, or as shown on the drawings. Redundant paths shall be installed where fill exceeds 40%.
- C. Provide pull strings in all conduits.
- D. Conduit bends shall accommodate radius requirements of fiber cable as necessary.

END OF SECTION 28 05 28

SECTION 28 23 00 – VIDEO SURVEILLANCE SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cameras
2. Camera housings
3. Lenses
4. Heaters and power supplies
5. Video storage system [needs to be added]
6. Video monitoring system [needs to be added]

B. Work Included:

1. Section includes adding cameras to the existing video surveillance system consisting of cameras, housings, and data transmission wiring. Cameras to terminate on owner provided Ethernet switches, located near CAT6 patch panels. Video Surveillance system head-end equipment is located in Administration Building (911 Call Center), and shall communicate to new equipment via existing IP network.

1.2 DEFINITIONS

- A. AGC: Automatic gain control.
- B. IP: Internet protocol.
- C. LAN: Local area network.
- D. NTSC: National Television System Committee.
- E. PC: Personal computer.
- F. TCP: Transmission control protocol – connects hosts on the internet.
- G. WAN: Wide area network.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings and finishes.
- B. Shop Drawings: For video surveillance, include plans, elevations, sections, details and attachments to other work.

- C. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
- E. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturers installation instructions
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station 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. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NECA 1.
- C. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

- A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - 1. Interior, Controlled Environment: System components, except central-station control unit, installed in air-conditioned interior environments shall be rated for continuous operation in ambient temperatures of 40 to 100 deg. F dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
 - 2. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 10 to plus 120 deg. F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph. Use NEMA 250, Type 4 or IP66 enclosures.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fall in materials or workmanship within specified period.
 - 1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 CAMERAS

- A. Manufacturers: Axis Communications, Model P3344 and P3344-V (for vandal resistant areas) with Lenel SW-LNR-CH1 single channel license for each new camera.
- B. Color Camera, Exterior.
 - 1. 5 megapixel CMOS image sensor.
 - 2. 2592H X 1944V pixel array.
 - 3. 1 / 2.5" optical format.
 - 4. 2.2 micro pixel pitch.
 - 5. Bayer mosaic RGB filter.
 - 6. Minimum illumination: Color 0.3 Lux # F1.4, Day/Night 0 Lux & IR sensitive.
 - 7. Dynamic range 70.1 dB.
 - 8. Maximum SNR 44.1 dB.
 - 9. Frame rate: Selectable 9 fps @ 2592 x 1944 to 32 fps @ 1280 x 1024.
 - 10. Video Signal: 100 Base-T Ethernet Network Protocol at up to 55 MBps.
 - 11. Optically coupled I/O.
 - 12. Power over Ethernet PoE 802.3 af.
- C. Color Camera, Interior.
 - 1. 1.3 megapixel CMOS image sensor.
 - 2. 1280H X 1024V pixel array.
 - 3. 1 / 2" optical format.
 - 4. Bayer mosaic RGB filter.
 - 5. Minimum illumination: Color 0.1 Lux # F1.4, Day/Night 0 Lux & IR sensitive.
 - 6. Dynamic range 61 dB.
 - 7. Maximum SNR 50 dB.
 - 8. Frame rate: Selectable 9 fps @ 2592 x 1944 to 32 fps @ 1280 x 1024.
 - 9. Video Signal: 100 Base-T Ethernet Network Protocol at up to 55 MBps.
 - 10. Optically coupled I/O.
 - 11. Power over Ethernet PoE 802.3 af.

2.3 REINFORCED DOMES

- A. Manufacturers: Subject to compliance with requirements, and compatible with camera supplied.
- B. Interior Domes:
 - 1. Aluminum Housing with vandal resistant polycarbonate cover.
 - 2. Allow for full 360 deg. horizontal and 0-90 deg. vertical camera rotation.
 - 3. Ceiling Mounts: Capable of recessed mounting in acoustical tile or drywall ceiling mounted locations.
 - 4. Wall Mounts: Capable of surface mounting in the horizontal or vertical position.
 - 5. White in color with dark lens.
- C. Exterior Domes:
 - 1. Aluminum Housing with vandal resistant polycarbonate cover.
 - 2. Allow for full 360 deg. horizontal and 0-90 deg. vertical camera rotation.
 - 3. Wall Mount: Capable of surface mounting in the horizontal position.
 - 4. White in color with dark lens.
 - 5. Provide with heater to allow for low temperature and high humidity conditions of environmental conditions described above.

2.4 LENSES

- A. Manufacturers: Axis Communications
- B. Lens: P3343/-V/-VE 6 and 12 mm varifocal

2.5 HEATER POWER SUPPLIES

- A. Low voltage power supplies matched for voltage and power requirements of housing heater as recommended by manufacturer of camera and housing.
- B. Enclosure: NEMA 250, Type 1, wall mount.

2.6 SIGNAL TRANSMISSION COMPONENTS

- A. Description: 100-ohm, 4-pair UTP, formed into 4-pair, binder groups covered with a blue thermoplastic jacket.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 - 3. Comply with TIA/EIA-568-B.2, Category 6.
 - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
- B. Jacks and Jack Assemblies: 100-ohm, balanced, twisted-pair connector, four-pair, eight-position modular RJ-45 plug units with integral IDC-type terminals rated for CAT 6 terminations. Comply with TIA/EIA-568-B.2.Cable.

2.7 SEISMIC PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Video surveillance system shall withstand the effects of earthquake motions determined according to ASCE/SEI7.
- B. The term “withstand” means “the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.”

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Coordinate final camera location and desired viewing angles with Owner.
- B. Coordinate location of LAN POE rated switch to be used with Owner.
- C. Examine pathway elements intended for cables. Check supporting hooks, raceways and other elements for compliance with space allocations, installation tolerance, and other conditions affecting installation. Provide new surface raceway where needed.
- D. Coordinate interior wall location for power supply serving exterior camera housings. Locate existing 120Vac, 15 or 20 amp, non-switched power source that can be tapped to feed power supply.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING

- A. Comply with requirements in Division 26 Section “Raceway and Boxes for Electrical Systems.”
- B. Wiring Method: Install cables in raceways unless otherwise indicated.
 - 1. Raceways are not required in accessible indoor ceiling spaces and attics.
 - 2. Utilize surface raceway in office and classroom spaces. Existing raceways may be reused where possible. New must be provided where not.
 - 3. For cables not installed in raceways:
 - a. Cables shall be supported with “J-Hooks” a minimum of every six feet. Bridal rings can be used when supporting a maximum of six wires. Support devices are to be attached to existing permanent structure.
 - b. Cables shall be installed in cable tray where available.
 - c. Cables shall be continuous from outlet to termination equipment.
 - d. Cables shall be terminated using tools recommended by the termination manufacturer.
 - e. Cables and supports shall be installed at a readily accessible location above ceilings.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer’s limitations on bending radii. Provide and use lacing bars and distribution spools.

- D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- E. For LAN connection and copper communication wiring, comply with Division 27 Sections "Communications Backbone Cabling" and "Communications Horizontal Cabling."
- F. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.3 VIDEO SURVEILLANCE SYSTEM INSTALLATION

- A. Install camera housings level and plumb.
- B. Install cameras with 96" minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.
- C. Install power supplies and other auxiliary components.
- D. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Assist Owner with modifying their network camera monitoring system to view new camera installations as desired.
- B. Tests and Inspections:
 - 1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
 - 2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
 - a. Prepare equipment list described in "Informational Submittals" Article.
 - b. Verify operation of auto-iris lenses.
 - c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
 - d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object distance appropriate for intended use of camera location. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
 - e. Set and name all preset positions; consult Owner's personnel.
 - f. Set sensitivity of motion detection.

- C. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
- D. Video surveillance system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Occupancy Adjustment: When requested within 6 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:
 - 1. Check cable connections.
 - 2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
 - 3. Adjust all preset positions; consult Owner's personnel.
 - 4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
 - 5. Provide a written report of adjustments and recommendations.

3.6 CLEANING

- A. Clean installed items using methods and materials recommended in writing by manufacturer.
- B. Clean video-surveillance-system components, including camera-housing windows, lenses and monitor screens.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

END OF SECTION 28 23 00

SECTION 28 30 00 – FIRE DETECTION AND ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire alarm system

B. Work Included:

1. Install a complete and operational addressable fire alarm system with live and recorded emergency voice communications as indicated by drawings, schedules, and riser diagrams. The system shall be connected to a UL Listed monitoring station which will notify the fire department and owners designated representative upon system activation. In jurisdictions required by ordinance to be UL Certificated per UL Category UUFX the documentation and UL Certificate shall be provided and posted at the job site.
2. The equipment supplier must be the local factory authorized representative and must also be factory authorized, trained and certified to perform warranty service for the equipment being supplied providing local factory authorized service and spare parts inventory. The supplier or installer must be NICET Certified level II, III or IV and NICET certificate must be submitted with shop drawings.
3. Equipment manufacturer shall be regularly engaged in manufacturer of fire alarm systems of types, sizes, and electrical characteristics required, and whose products have been in satisfactory use in similar service for not less than 5 years.
4. Installer shall have at least 5 years of successful experience on projects with fire alarm systems work similar to that required for this project and be a licensed contractor.
5. For a period of one year from date of Owner's first beneficial use, the system shall be under a no charge warranty/service contract, as authorized by the manufacturer. During that period, replacement components and labor shall be readily available during standard business hours. After the one-year guarantee period, the supplier warrants that he is capable of providing service on a 24 hour, 7-day a week basis for at least five (5) additional years.

1.2 SUBMITTALS

A. Provide shop drawings in accordance with the appropriate paragraphs the applicable version of NFPA 72 for the following items:

1. Written narrative providing intent and system description.
2. Floorplan layout showing location of all devices, including isolation components to comply with the applicable NFPA 72 chapter on the Performance of Signaling Line Circuits (SLCs) referencing fault tolerances and manufacturer's specific product requirements, strobe candela ratings, speaker taps, control equipment, supervising station equipment. Include point of compass (north arrow), scale used, room use identification and building features that will affect installed devices such as shelving or floor mounted equipment such as kitchen equipment.
3. Sequence of operation in a matrix form.

4. Equipment data sheets.
 5. Battery and voltage drop calculations.
 6. Mounting elevations of wall mounted equipment.
 7. Wiring pathway diagrams.
 8. Provide NICET level II, III or IV (minimum) certificate of individual responsible for the design and calculations of the fire alarm system.
 9. Manufacturers published instructions including operation and maintenance manuals. (Hard copy of information shall be left with owner)
 10. Record of Completion, per applicable NFPA 72. (Hard copy of information shall be left with owner)
 11. Site specific software in the form of a thumb drive.
 12. Record (as built) drawings. (Hard copy of information shall be left with owner)
 13. Completed record of inspection and testing per NFPA 72 (Hard copy of information shall be left with owner)
- B. Submittals shall be submitted in two packages; the first package shall include items 1-7 and 13. Package two shall include items 8-12 submitted after project is completed. Partial submittal packages may be returned as rejected without being reviewed.
- C. Engineered sealed fire alarm drawings prepared by fire alarm supplier required for permit application are the responsibility of the Contractor and fire alarm system supplier. Coordinate any system design drawing submission requirements with the Engineer.

1.3 REFERENCES, RELATED SECTIONS of the SPECIFICATIONS

- A. Requirements of the following Sections of the Specifications apply to Work for this Section:
1. Division 26 – Electrical
 2. Division 28 – Electronic Safety and Security

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

2.2 MANUFACTURERS

- A. Notifier
- B. Edwards Systems Technologies
- C. Simplex
- D. Siemens

2.3 PRODUCTS

A. Fire Alarm Control Panel

1. The Fire Alarm System will be microprocessor based, non coded, and utilize addressable devices with integrated or adjacently mounted voice controls. It will be electronically supervised, common signaling, individual device indicating, with remote central station monitoring. The system shall operate from manual fire alarm stations, smoke detectors, thermal detectors, duct smoke detectors, water flow, and tamper switches.
2. The panel shall include an integral 80 character LCD display that can be viewed without opening the front cover of the control panel. Located within the panel or adjacently mounted to the panel there shall be a microphone, speaker selection switches and voice control equipment including amplifiers and audio message generators. Systems specified without selectable speaker zones (general alarm) shall not require speaker selection switches. See paragraph I Sequence of Operations for requirements.
3. The panel shall include SLC loop modules for a minimum of 198 addressable points. Addressable points shall include at a minimum 99 modules such as relays, monitor points and manual stations and 99 addressable detectors such as smoke, heat or CO. Additional loop modules or loop capacity must be provided to assure 40% spare addresses for any type of device added to the system.
4. The system shall transmit alarm signals to a remote central station in full compliance with NFPA 72. The batteries will be able to operate the system under maximum normal load condition for not less than 24 consecutive hours followed by fifteen (15) minutes of alarm.
5. Provide a low voltage, 24 volt DC fire alarm control panel including all circuitry, amplifiers, power supplies, batteries, programming and cabinet space necessary to perform required functions, and to service as test and trouble signal points.
6. All input/output cards shall be modular, plug in type devices.
7. Equip control panel for number of initiating addresses as required plus 40% spare capacity. Provide 25% spare amplifier capacity.
8. The control panel shall include the following additional features:
 - a. Walk test feature for single person testing of the system. This feature includes special audible indication and zone trouble indication.
 - b. Alarm verification, programmable per device.
 - c. Totally field programmable with multiple password protection.
 - d. All initiation and indication circuits shall be power limited for use with limited energy cables.
 - e. Addressable monitor modules may be field programmed for normal water flow or supervisory operation.
 - f. Any output control/relay module circuit may be mapped to any input device in non volatile program memory.
 - g. Display program function allows system field program information to be easily displayed using front panel controls.
 - h. Disable capability for each device shall be provided from the control panel.
 - i. A 1000 event history log stored in non volatile memory with storage of alarm verification activities.
 - j. Serial annunciator port shall be provided for high-speed 4-wire annunciation of the system.
9. Contractor to provide dedicated 20A, 120VAC power connections to fire alarm control panel, amplifier cabinets and fire alarm strobe extender power panels.

10. Provide and install clamp-on breaker locking cleats manufactured by Brady, Space Age Electronics, or equivalent for all breakers serving the fire alarm system components. Each breaker shall be labeled with a red identifier noting "fire alarm". Coordinate with Division 26 contractor.
- B. Integrated Fire Alarm Communicator:
1. The FACP shall include a UL Listed integrated commercial fire digital communicator complete with the following features:
 - a. Meet NFPA 72 requirements for Digital Alarm Communicator Transmitter.
 - b. Capable of seizing the telephone line at the protected premises, disconnecting an outgoing or incoming call, and preventing its use until signal transmission has been completed.
 - c. Connections for two separate telephone lines at protected premises.
 - d. Capable of selecting the operable line in the event of a failure on either line.
 - e. Programmed to call a second number should the signal transmission be unsuccessful.
 - f. The digital communicator shall be connected to the fire alarm system to receive and transmit alarm signals, trouble conditions and supervisory conditions using Contact ID transmission protocol.
 2. The system shall include a dual path commercial fire alarm communicator with cellular and IP communication capabilities (Honeywell #IPGSM-4G or equal). The Contractor shall provide cable, connectors and installation of IP data cables from the data rack. The communicator will transmit each event as digital information over the IP and cellular network. The contractor shall test the signal of the cellular antenna and provide additional antennae as required to produce a reliable cellular signal.
- C. Remote Annunciator/Remote Microphone
1. Remote annunciator panel shall include an 80-character backlit LCD display to mirror the fire alarm control panel display and piezo sounder to notify of system trouble. Provide a microphone with speaker selector switches in the same enclosure with the remote annunciator or a general remote paging microphone as specified in section I Sequence of Operations.
 2. Remote annunciator/microphone to be provided with key lock switch and control keypad for system acknowledge, audible signal silence, system reset functions and speaker zone selection if specified in paragraph I Sequence of Operations.
 3. Flush or surface mounting of remote annunciator panel to be coordinated prior to installation.
- D. Field Devices
1. Manual Fire Alarm Stations: Addressable non coded, red semi flush, dual action manual station manufactured of Lexan with clearly visible operating instructions on the cover. Where noted on drawings, provide a Safety Technology International Stopper II cover without horn.
 2. Photoelectric Detectors: Addressable photoelectric smoke detectors shall use the photoelectric (light-scattering) principal to measure smoke density. Provide detectors as shown on plans and as a minimum provide a smoke detector at control panel and each remote power supply location.
 3. Duct Detector: Addressable photoelectric duct mounted smoke detector with sampling tube and protective housing. Provide remote test switches or remote LED's where noted on plans. Contractor to provide all load relays necessary for fan shut-down. Note: When using a duct smoke detector to activate the closure of a fire/smoke damper, the damper

shall close any time the air distribution fan serving the respective duct is not running. This may be accomplished by directly monitoring the fan status or BAS interface. Coordinate with mechanical engineer for proper interface.

4. Thermal Detector: Addressable fixed temperature low profile device with twist lock base. Temperature rating to be 135 degrees or 190 degrees (High temp version). In elevator equipment rooms and shafts, heat detectors shall be located within two feet of each sprinkler head.
5. Relay Modules: Addressable relay modules with LED indicator light.
6. Control Modules: Addressable control modules with LED indicator light.
7. Monitor Modules: Addressable monitor modules with LED indicator light.
8. Door Holders: Flush wall mount electromagnetic door holder controlled by fire alarm system. Provide extension rods or box extensions as necessary. Door Holders shall be 24V or 120V powered. Provide power supplies as necessary. Label power supplies "Door Holder Power Supply". Door Holders provided by Door Hardware Supplier or Door Holders provided by fire alarm supplier. At the contractors option provide either 24 volt or 120 volt door holders for this project.
9. Beam Detector Open Area: {choose one beam detector type} Multi beam smoke detector shall support as many as seven emitters placed within the field of view of a single imager, each placed at different heights. The imager's large viewing angles, both horizontal and vertical, enable three-dimensional area coverage for design flexibility and additional deployment savings. The detector is a combined transmitter/receiver unit that can be directly connected to a conventional FACP zone input or to an addressable/intelligent FACP using monitoring modules. Provide with multi angle surface mounting kit (if required based on required mounting angles) and remote test switches where noted on plans.
10. Beam Detector Reflective: {choose one beam detector type} Single ended beam smoke detector allows the detector to find and lock onto a standard reflector, automatically set the detector sensitivity, track the reflector, resulting in the elimination of nuisance alarms due to building movement. The detector is a combined transmitter/receiver unit that can be directly connected to a conventional FACP zone input or to an addressable/intelligent FACP using monitoring modules. Provide with multi angle surface mounting kit (if required based on required mounting angles) and remote test switches where noted on plans.
11. Carbon Monoxide Detector: Provide an addressable CO detector that looks similar to an addressable smoke detector. The detector shall be connected to the SLC circuit and include an audible base providing a code 4 temporal pattern. If addressable CO detectors are unavailable by the specific system supplier a 4-wire carbon monoxide detector monitored by a fire alarm system monitor module with local alarm sounder and trouble relay will be considered equal. Mount per manufacturer's instructions.
12. All initiating devices shall be identified with a black-on-clear (1/4" text minimum) printed adhesive label affixed to the device. This label shall include the device address.

E. Signaling Appliances

1. Speakers. Speakers shall be combined with strobes or stand alone as indicated on plans. Speakers shall be wall or ceiling mounted and white in color.
 - a. All speakers shall operate on 25 VRMS or with field selectable output taps from 0.25 to 2.0 Watts.
 - b. Speakers in corridors and public spaces shall produce a minimum nominal sound output of 83 dBA at 10 feet (3m).

- c. Frequency response shall be a minimum of 400 HZ to 4000 HZ.
 - d. The back of each speaker shall be sealed to protect the speaker cone from damage and dust.
 - 2. Strobes. Strobes shall be wall or ceiling mounted and white in color. Strobes shall be combined with speakers or stand alone as indicated on plans. Strobe lights shall be multi-candela units and meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:
 - a. The maximum pulse duration shall be 2/10 of one second.
 - b. Strobe intensity and flash rate shall meet the requirements of UL 1971.
 - c. Strobes shall be synchronized.
 - d. The signals shall operate on 24 VDC polarized and the device shall be able to test circuit supervision without disconnecting wires.
 - e. There shall be FIRE lettering clearly visible from both sides. Red or white device color to be coordinated with Architect.
 - f. Visual and audible devices shall be synchronized within the project area and synchronized with all adjacent areas. This Contractor and equipment supplier shall provide cabling and equipment to achieve synchronization between the project area and adjacent spaces- including but not limited the installation of synchronization modules, Sync Protocols, replacement of power supplies, replacing strobes without synchronization capability, and associated cabling. Locating existing power supplies outside the project area shall be the responsibility of the Contractor/equipment suppliers.
 - 3. Provide remote strobe signal expander power supplies as necessary. Provide dedicated 20A, 120V circuit to each remote power supply or group of power supplies not exceeding 80% of AC circuit capacity.
- F. Waterflow Exterior Signaling Appliances
- 1. Potter SASH -120 volt exterior audible/visual alarm signal representing sprinkler system activation.
 - a. Device shall operate on 120 volt and connected to a set of contacts from the main waterflow switch.
 - b. Device shall be outdoor rated and include verbiage identifying a “sprinkler alarm” and call 911.

PART 3 - EXECUTION

3.1 SYSTEM WIRING

- A. All wiring will be as required by the Equipment Supplier. Wire color-coding and the color shall remain the same throughout the system. In general, all initiating devices such as manual stations, smoke detectors and all modules will be installed across a common #18AWG twisted unshielded pair or as required by system supplier. The strobe circuits shall require #14AWG unshielded or as required by system supplier. The speaker circuits shall require #16AWG shielded cable or as required by system supplier.
- B. No conduit or raceway system will include Class I or non-power limited fire protection signaling circuits with Class II or power limited fire protection signaling circuits in accordance with N.E.C. Article 725 or 760.

- C. All conduit and wiring to flow switches, tamper switches, etc., shall be furnished and installed as part of this work.
- D. Test results shall be submitted to Engineer per this specification section.
- E. Wiring may be run as concealed open type plenum rated cable. Exposed or inaccessible wiring shall be installed in conduit. Where possible wiring/conduit shall be concealed. Provide sleeves in all walls which cable runs pass through. Refer to 26 05 29 for fire sealing of penetrations through fire rated walls. Provide access panels as necessary for cable routing. Support devices are to be attached to existing permanent structure.

3.2 SEQUENCE OF OPERATIONS

- A. Fire alarm system shall evacuate entire building in the event of an alarm. The evacuation signal shall begin with a pre-announce tone in a code 3 temporal pattern repeated 3 times followed by the evacuation message. The message shall repeat until silenced or overridden by operators at the FACP or remote annunciator/microphone station with live voice instructions. Evacuation message shall be approved by the AHJ.

##DEFINE EVACUATION ZONES##

- B. The following will occur upon activation of any alarm initiating device (smoke detector, heat detector, manual pull station and water flow monitor module):
 - 1. Sound audible signals and flash visual signals.
 - 2. Display alarm status information on the fire alarm control panel, each remote annunciator and send an alarm signal to the remote supervising station.
 - 3. Activate addressable control modules to shut down air handling units, close fire/smoke dampers and release all smoke doors.
 - 4. Upon elevator lobby, elevator equipment room or elevator shaft detection, primary or alternate recall module contacts will close to activate elevator recall. Upon equipment room or shaft detection, an additional control module contact will close for a signal to the elevator cab.
 - 5. Upon activation of elevator hoist way or elevator equipment room heat detectors the elevator power shunt trip fusible switch shall be caused to trip open.
 - 6. Activate auditorium egress lighting.
- C. The following to occur upon activation of a trouble signal (open circuit, ground fault, low battery, loss of AC power, etc.):
 - 1. Display trouble status at the fire alarm control panel, each remote annunciator and send a trouble signal to the remote supervising station.
- D. A system duct detector activation shall shut-down all air handling units, display supervisory status at the fire alarm control panel, each remote annunciator and send a supervisory signal to the remote supervising station.

OR

- E. Tamper switch state change shall display supervisory status at the fire alarm control panel, each remote annunciator and send a supervisory signal to the remote supervising station
- F. Exterior horn/strobe at fire department connection to only activate on water flow.
- G. Kitchen hood fire detection to initiate full building alarm equal to the activation of a manual station or smoke detector.
- H. Carbon monoxide detector activation shall display supervisory status at the fire alarm control panel, each remote annunciator and send a supervisory signal to the remote supervising station
- I. The fire pump to be monitored by the fire alarm system to send alarm signals to the fire alarm control panel for 'Pump Running', and supervisory signals for 'Phase Reversal' and 'Pump Power Source'. The emergency feeder overcurrent device position shall be monitored and produce a trouble signal if open.

3.3 EXISTING FIRE ALARM SYSTEM AND FIRE PROTECTION SYSTEM DISTURBANCE

- A. When adding or deleting fire alarm devices care must be taken to assure the existing system will continue to work if an alarm, trouble or supervisory event occurs. When deleting existing addressable devices the address must be deleted or temporarily disabled in the program before the completion of work on any given day. When adding new devices the address must be programmed or temporarily disabled before the completion of work on any given day. Signaling appliances added to any system must maintain parallel supervised wiring with the end of line device in-tact before the completion of work on any given day. Only if all parties agree (owner, and AHJ) that the fire alarm system shall be out of service overnight shall a system be allowed to be placed in an out of service condition.
- B. Where fire protection is reworked/removed from the construction site, The Division 28 contractor shall furnish and install heat detectors in all areas of construction. Heat detector coverage shall be reworked as required in the event construction barrier changes occur or construction phase changes. The Contractor and an approved equipment supplier of the system manufacturer shall include all necessary programming changes to install and remove heat detectors.

END OF SECTION 28 30 00

SECTION 31 10 00 – SITE CLEARING

PART 1 – GENERAL

1.1 WORK INCLUDES

- A. Clear site of plant life and grass.
- B. Remove:
 - 1. Trees and shrubs where indicated.
 - 2. Root system of trees and shrubs.
 - 3. Surface debris.
 - 4. Vegetation.
- C. Perform clearing and grubbing operations.
- D. Protect benchmarks; repair damage to all areas outside contract limits to match specified new work.

1.2 RELATED WORK

- A. Specified Elsewhere:
 - 1. Section 02 41 00 – Site Demolition
 - 2. Section 31 23 16 – Excavation
 - 3. Section 31 25 00 – Erosion & Sedimentation Control

1.3 REGULATORY REQUIREMENTS

- A. Conform to all applicable local, state, and federal codes for disposal of debris.
- B. Coordinate all site clearing work with the utility companies.

1.4 REFERENCES

- A. Conform to the applicable portions of Sections 201 and 202 of the Missouri Department of Transportation (MoDOT): Standard Specifications for Highway Construction, including all Supplemental Specifications and Recurring Special Provisions.

1.5 PROJECT CONDITIONS

- A. Conduct removals to minimize interference with adjacent building areas. Maintain protected egress and access at all times.
- B. Provide, erect and maintain temporary traffic control and security devices in accordance with the standard details and drawings included in the contract documents.
- C. Do not close or obstruct roadways and sidewalks without permits and Owner approval.
- D. Accept premises as found. Neither Owner, nor Engineer assumes responsibility for condition of areas or continuation of areas in condition existing at or after date of bidding documents.

1.6 SUBMITTALS (RESERVED)

PART 2 – PRODUCTS (RESERVED)

PART 3 – EXECUTION

3.1 CLEARING

- A. Clear designated areas for access to site and execution of work.
- B. Remove designated trees and shrubs, grass, weeds and other vegetation. Grub out stumps, roots, rocks, and obstructions which interfere with installation of new work.
- C. Clear undergrowth and deadwood, without disturbing subsoil.

3.2 PROTECTION

- A. Protect plant growth and features remaining for final landscaping.
- B. Protect bench marks and existing work from damage or displacement.
- C. Maintain designated site access for vehicle and pedestrian traffic.
- D. Protect existing active utility lines during construction.
- E. Utility lines encountered during construction that are not scheduled to be removed must be protected, relocated, or scaled and capped by appropriate trades having jurisdiction.
- F. Protect all existing items not indicated to be removed.

3.3 REMOVAL

- A. Remove all waste materials from the Owner's property and legally dispose of same.
- B. All topsoil shall be stockpiled onsite or at a location as approved by the Owner. Any excess topsoil shall be removed from the project site and properly disposed of off-site.
- C. Do not store debris, remove as it accumulates. If Contractor fails to remove debris promptly, the Engineer reserves the right to cause same to be removed at Contractor's expense. Debris may not be burned or buried on the site.
- D. Provide all measures of protection required by state authorities, regulations, and laws for protection of surrounding property, sidewalks, curbs, the public and all employees during removal operations. Measures taken, including sidewalks, sheds (if required), barricades, warning lights and signs, and rubbish chute (if required), shall be in strict accordance with the American Standard Building Construction A10-2-1944 and all applicable state and federal laws. Provide all protection as required by codes having jurisdiction and maintain until no longer necessary.

3.4 CLEAN UP

- A. Upon completion of work remove tools, materials, apparatus, debris and rubbish of every sort. Leave premises clean, neat and orderly.

END OF SECTION 31 10 00

SECTION 31 22 13 – ROUGH GRADING

PART 1 – GENERAL

1.1 WORK INCLUDES

- A. Excavate subsoil and stockpile for later reuse. Remove excess from site.
- B. Grade and rough contour site improvement areas.

1.2 RELATED WORK

- A. Specified Elsewhere:
 - 1. All Sections of Division 31 and 32.

1.3 SUBMITTALS

- A. Accurately record location of remaining, rerouted or new utilities by horizontal dimensions, elevations or inverts, and slope gradients on Contract Documents.
- B. Submit test results of compaction testing – See Section 31 23 23 - Fill.

1.4 REFERENCES

- A. Conform to the applicable portions of Division 200 of the Missouri Department of Transportation (MoDOT): Standard Specifications for Highway, including all Supplemental Specifications and Recurring Special Provisions.
- B. Project Geotechnical Report and its recommendation will be made available to the bidders/contractors.
 - a. The report is provided to contractors for reference and information.
 - b. There may be perceived or real deviation or conflict between the report, its recommendations and Contract Documents; if so contact Engineer for direction.

1.5 PROTECTION

- A. Protect existing trees, shrubs, lawns and other features remaining as portion of final landscaping.
- B. Protect benchmarks, existing structures, fences, roads, sidewalks, paving, curbs and all other items to remain.
- C. Protect above- or below-grade utilities which will remain.
- D. Protect work from damage caused by settlement or movement caused by rough grading.
- E. Repair damage.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Subsoil: Excavated material (other than topsoil) which is graded free of lumps larger than 6 inches, rocks larger than 3 inches and debris.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Identify specified lines, levels, contours and data.

- B. Identify known below grade utilities. Stake and flag locations.
- C. Identify and flag above grade utilities.
- D. Maintain and protect existing utilities remaining which pass through work area.
- E. Notify Utility Companies to remove and relocate necessary utilities.
- F. Upon discovery of unknown utility or concealed conditions, discontinue affected work and notify the Engineer immediately. Confirm notification in writing.
- G. Visit the site and become familiar with all existing conditions under which work is to be performed.

3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout or damage by rain or water accumulation.
- C. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 SUBSOIL EXCAVATION

- A. Excavate subsoil from areas to be re-landscaped or regraded and stockpile in area designated on site. Remove excess subsoil not being reused from Project site.
- B. Excavate and remove all organic, loose or obviously compressive materials. The subgrade shall then be proof-rolled until the grade offers an unyielding surface and until the specified compaction is achieved; refer to Section 31 23 23 - Fill. Areas of excessive yielding shall be excavated and backfilled with clean, compacted soil that meets the approval of the Engineer.
- C. Do not excavate wet subsoil.
- D. Stockpile subsoil to depth not to exceed 4 feet.
- E. When excavating through roots, perform work by hand and cut roots with a sharp axe.

3.4 TOLERANCES.

- A. Top surface of subgrade: Plus or minus 1 inch.

3.5 TESTING AND COMPACTION.

- A. Refer to Section 31 23 23 - Fill.

END OF SECTION 31 22 13

SECTION 31 23 16 – EXCAVATION

PART 1 – GENERAL

1.1 WORK INCLUDES

- A. Excavating for sewers, pavements, sidewalks, curbs and gutter and incidental work.
- B. Removal and off-site satisfactory disposal of unstable and unsuitable materials.

1.2 RELATED WORK (RESERVED)

1.3 REGULATORY REQUIREMENTS

- A. Codes and Standards:
 - 1. Conform to the applicable portions of Section 203 of the Missouri Department of Transportation (MoDOT): Standard Specifications for Highway Construction, including all Supplemental Specifications and Recurring Special Provisions.
 - 2. Prior to the commencement of construction, the Contractor shall be aware of, and become familiar with applicable local, state and federal safety regulations, including the current OSHA Occupational Safety and Health Standards - Excavations, 29 CFR Part 1926, including any successor regulations.
 - 3. Additionally, the Contractor shall be aware that slope height, slope inclination and excavation depths (including utility trench excavations) should in no case exceed those specified in local, state or federal safety regulations.

1.4 COORDINATION

- A. Do not interrupt existing utilities serving facilities occupied and used by Owner or others except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided. Provide minimum of 48-hour notice prior to enacting an approved temporary interruption.

1.5 SUBMITTALS (RESERVED)

PART 2 – PRODUCTS (RESERVED)

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Site Information
 - 1. Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn there from by Contractor. Data are made available for convenience of Contractor.
 - 2. Contractor shall be responsible for determining the actual ground water elevation and soil conditions at the specific site prior to commencing with the excavation. It may be expedient to drill auger holes, excavate test pits or make additional soil borings at or adjacent to the construction area immediately prior to construction to determine the prevailing soil conditions and water table elevation. It is the Contractor's responsibility to make auger holes, excavate test pits or make additional soil borings, as he deems appropriate to determine the ground water and soil conditions that will be encountered. Additional test borings and other exploratory operations made by the Contractor shall be at no cost to the Owner.

3.2 PREPARATION

- A. Establish extent of excavated areas.
- B. Identify and set required lines, levels and contours.
- C. Maintain benchmarks, monuments and other reference points.
- D. Before starting excavation, establish location and extent of underground utilities occurring in work area. Contact Joint Utility Locating Information for Excavators (J.U.L.I.E.) (800) 892-0123 or all other utility companies on the project site which are not members of this system.

3.3 EXCAVATION

A. General

- 1. Excavation consists of removal and redistribution of material encountered when establishing required grade and subgrade elevations, including stripping of topsoil.
- 2. The Contractor is solely responsible for designing and constructing stable excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. All excavations shall comply with applicable local, state and federal safety regulations including the current OSHA Occupational Safety and Health Standards - Excavations, 29 CFR Part 1926, including any successor regulations.
- 3. All sheeting, shoring and bracing of trenches, pits and excavations shall be the sole responsibility of the Contractor.
- 4. Construction site safety is the sole responsibility of the Contractor, including but not limited to, the means, methods, and sequencing of construction operations.
- 5. Earth excavation consists of stripping of topsoil, removal and disposal of pavements and other obstructions visible on ground surface, underground structures and utilities indicated to be demolished and removed, material of any classification indicated in data on sub-surface conditions, and other materials encountered that are not classified as unauthorized excavation.

B. Unauthorized Excavation

- 1. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of the Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be at Contractor's expense. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, only when acceptable to the Engineer. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of the same classification, unless otherwise directed by Engineer.

C. Additional Excavation

- 1. When excavation has reached required sub-grade elevations, notify Engineer who will make an inspection of conditions. If unsuitable bearing materials are encountered at required sub-grade elevations, carry excavations deeper and replace excavated material as directed by Engineer. Removal of unsuitable material and its replacement as directed will be paid on basis of contract conditions relative to change in work.

D. Dewatering

- 1. Prevent surface water and subsurface or ground water from flowing into excavation and from flooding project site and surrounding area.
- 2. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering

system components necessary to convey water away from excavations.

3. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

E. Material Storage

1. Stockpile satisfactory excavated materials in the location designated by the Engineer or Owner, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain. Contain excavated silt/soil runoff with silt fences in accordance with Local, State and Federal Requirements.

F. Excavation Near Utilities

1. Protect, support, shore, brace, etc. all utility services uncovered by excavation.
2. Accurately locate and record abandoned and active utility lines rerouted or extended, on Contract Documents.
3. Repair damaged utilities to the satisfaction of the Utility Owner.

G. Disposal of Excess and Waste Materials

1. Removal from Owner's Property
 - a. Remove waste materials, trash and debris and legally dispose of it off Owner's property.
2. Excess Material
 - a. Excess excavated material shall be removed from the site and properly disposed of.

H. Topsoil

1. Topsoil shall be stripped from site so that all organic materials, stumps, and roots are removed from the site.
2. Contractor shall stockpile sufficient clean topsoil onsite for reuse and shall dispose of all excess or unsuitable material in accordance with existing state and federal regulations.
3. Temporary topsoil stockpiles shall be temporarily stabilized as required.

3.4 FIELD QUALITY CONTROL

- A. The Contractor shall allow bearing surfaces at the bottom of excavations to be inspected by the Engineer, and shall modify the bearing surfaces as requested by the Engineer, prior to placement of any base materials.
- B. Proofrolling. Subgrades shall be proofrolled to detect areas of insufficient compaction. Proofrolling shall be accomplished by making minimum of 2 complete passes with fully-loaded tandem-axle dump truck with a maximum weight of 20 tons, or approved equal, in each of 2 perpendicular directions while under the supervision and direction of the independent testing laboratory. Areas of failure shall be excavated and recompact as specified herein. Continual failure areas shall be stabilized at no additional cost to Owner. Subgrade exposed longer than 48 hours or on which precipitation has occurred shall be re-proofrolled.

3.5 PROTECTION

A. Stability of Excavation

1. Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible either because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

B. Cold Weather Protection

1. Protect excavation bottoms against freezing when atmospheric temperature is less than 35°F (1°C).

C. Protection of Persons and Property

1. Fence and barricade open excavations occurring as part of this work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required by authorities having jurisdiction.
2. Protect structures, landscaping, utilities, sidewalks, pavements or other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
3. Comply with current OSHA Occupational Safety and Health Standards - Excavations, 29 CFR Part 1926, including any successor regulations.

END OF SECTION 31 23 16

SECTION 31 23 23 – FILL

PART 1 – GENERAL

1.1 WORK INCLUDES

- A. Preparation of subgrade for pavements, sidewalks and curb and gutters.
- B. Backfill for site utilities.
- C. Fill for over-excavation.
- D. Consolidation and compaction of all fill material.

1.2 RELATED WORK

- A. Specified Elsewhere:
 - 1. Section 31 23 16 – Excavation
 - 2. Section 32 12 16 – Asphalt Paving
 - 3. Section 32 13 13 – Concrete Paving

1.3 REFERENCE TO STANDARDS

- A. ASTM D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).
- B. ASTM D4253 - Maximum Index Density and Unit Weights of Soils Using a Vibratory Table.
- C. Missouri Department of Transportation (MoDOT): Standard Specifications for Highway, Latest Edition.
- D. Project Geotechnical Report and its recommendation will be made available to the bidders/contractors.
 - a. The report is provided to contractors for reference and information.
 - b. There may be perceived or real deviation or conflict between the report, its recommendations and Contract Documents; if so contact Engineer for direction.

1.4 REGULATORY REQUIREMENTS

- A. Conform to the applicable portions of Sections 203 of the Missouri Department of Transportation (MoDOT): Standard Specifications for Highway Construction, including all Supplemental Specifications and Recurring Special Provisions.

1.5 SUBMITTALS

- A. Submit copies of Standard Proctor Density Test results to Engineer a minimum of seven business days prior to backfilling any excavations.

1.6 QUALITY ASSURANCE

- A. Compaction Testing
 - 1. Standard Proctor Density Testing and Compaction Testing of fill materials and inspection of subgrades and fill layers will be performed by the Contractor's testing service, using Proctor information furnished by the Contractor.

2. If, in opinion of Engineer, based on testing service reports and inspection, subgrade or fills, which have been graded or placed on-site are below specified density, provide additional compaction and testing at no additional expense to the Owner.
3. When, during progress of work, tests indicate that compacted materials will not meet specifications, remove defective work, replace and retest at no additional cost to the Owner.
4. Ensure that all compacted fills are tested before proceeding with placement of surface materials.

1.7 FIELD TESTS

A. Compaction Tests

1. Contractor shall make arrangements with an independent laboratory for completing compaction tests and shall pay for those tests. They shall also make arrangements with testing firm to have sufficient number of personnel from the testing laboratory and testing equipment in good working order during all placement and compaction operations. Name of testing firm chosen by Contractor shall be submitted to Engineer for approval prior to beginning of backfilling. Engineer reserves right to reject testing firm at any time during construction and to require another testing firm to perform tests.

1.8 PROTECTION

- A. Protect and avoid all existing underground utilities during construction operations. Repair of any utilities damaged by construction shall be the responsibility of the respective Contractor.

PART 2 – PRODUCTS

2.1 DEFINITIONS

A. Suitable Soil

1. Suitable soil is a soil having less than 5% organic matter by weight as determined by the Loss on Ignition Test (determine weight loss caused by heating sample to 500° C for 6 hours after drying in accordance with ASTM D-2216, "Laboratory Determination of Moisture Content of Soil").

B. Unsuitable Soil

1. Unsuitable soil is a soil that contains 5% or more organic matter as determined by the Loss of Ignition Test previously specified, rubbish, vegetable matter of every kind, roots, and boulders larger than 5 inches in dimension which might interfere with the proper bonding to adjacent contact surfaces, or as otherwise determined unsuitable by the Engineer.

C. Cohesive Soil

1. Cohesive soil is a soil containing more than 50 percent fine material passing the No. 200 standard sieve, and with more than 15 percent clay-size particles smaller than 0.002 mm (2 microns). The soil matrix passing the No. 40 standard sieve exhibits dry (crushing) strength in the dry state and cohesive shear strength in the moist state, as well as being plastic in the moist state.

2.2 ENGINEERED FILL MATERIALS

A. General

1. Fill material shall be as recommended by the geotechnical engineer as denoted in the Fill Material Types table in the Geotechnical Engineering Report for the project. Material should be approved by geotechnical engineer. Existing undocumented fill, if used for engineered or structural fills, should be approved by the materials testing firm. This material should be removed and recompacted if used as an engineered or structural fill as described in the geotechnical report.
2. Engage a qualified independent testing laboratory to test materials from on-site and off-site sources to test materials for conformance to this specification. The name of the testing laboratory shall be submitted to the Engineer for review prior to conducting any tests. Results of tests shall be submitted to the Engineer for review prior to engineered fill material being placed.

2.3 TRENCH BACKFILL MATERIALS

- A. General Fill and Cohesive Backfill
 - 1. Provide acceptable soil materials for backfill, free of clay lumps, rock or gravel larger than two inches in dimension, debris, waste, frozen materials, vegetable and other deleterious matter.
- B. Granular Backfill and Trench Backfill
 - 1. Granular backfill shall consist of MoDOT Type 1 or Type 5 aggregate. Granular backfill shall be used under steps, stoops, walks, roads, parking lots and against structure walls. (Minimum 4-inch depth below walks, steps, etc.).

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Prior to placement of any fill or backfill and prior to placement of all subsequent fill lifts, contact Engineer for inspection and testing of excavation subgrade and testing of each compacted layer of fill and backfill material. Provide proctor information necessary for the Engineer to perform density testing on in-place backfill material.

3.2 PREPARATION

- A. Backfilling and compaction shall not occur until the following conditions are satisfied:
 - 1. Acceptance by Engineer of construction below finish grade.
 - 2. Inspection, testing, approval and recording locations of underground utilities.
 - 3. Removal of concrete formwork.
 - 4. Removal of trash and debris, vegetation, snow or ice, water, unsatisfactory soil materials, obstructions and deleterious materials.
 - 5. Removal of shoring and bracing and backfilling of voids with satisfactory material.
 - 6. Ensure that ground surface within excavated area to be backfilled is not frozen.
 - 7. When existing ground surface has a density less than that specified under Article 3.3-C of this Section for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content and compact to required depth and percentage of maximum density. The Contractor shall be required to proofroll native soils as recommended in the geotechnical report prior to placing fill materials.

3.3 BACKFILLING AND COMPACTING

- A. General
 - 1. Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below.
 - a. In existing turf areas, use satisfactory excavated or borrow exterior fill material.
- B. Placement and Compaction
 - 1. Place backfill, base and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand operated tampers. Heavy equipment including compaction equipment shall not operate within 2 feet of unbraced substructure walls.

2. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen or contain frost or ice.
 3. Place backfill and fill materials evenly adjacent to structure to required elevations. Take necessary precautions to prevent wedging action of backfill against structures by carrying the material uniformly around structure to approximately same elevation in each lift.
- C. Percentage of Maximum Density Requirements
1. Unless otherwise noted on the plan sheets, all fill material shall be compacted to not less than 95% of ASTM D698, Standard Proctor Compaction Test or as otherwise recommended in the project geotechnical report. All utility trenches shall be compacted to 8% of ASTM D698.
- D. Moisture Control
1. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water top surface or subgrade or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
- E. Grading
1. General
 - a. Uniformly grade areas within limits of excavation under this Section, including adjacent transition areas. Compact with uniform levels or slopes between such points and existing grades.
 - b. Remove stones over 1-1/2" in any dimension and sticks, roots, rubbish and other extraneous matter.
 - c. Rough grade to 6" - 12" below finish, grades and elevations indicated in the drawings.
 - d. Grading Outside Structure Lines
 1. Grade areas adjacent to building lines to drain away from structures and to prevent ponding.
 2. Finish surfaces free from irregular surface changes, and as follows:
 - a. Slabs: Shape surface of areas under slabs to line, grade and cross-section, with finish surface not more than 1/2" above or below required subgrade elevation.
 2. Grading Surface of Backfill Under Walks and Slabs.
 - a. Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/4" when tested with a 10' straightedge.
 3. Compaction
 - a. After grading, compact subgrade surfaces to the depth and percentage of maximum or relative density for each area classification.
- F. Maintenance
1. Protection of Graded Areas
 - a. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

- b. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
- 2. Reconditioning Compacted Areas
 - a. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape and compact to required density prior to further construction.
- 3. Settling
 - a. Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality and condition of surface or finish to match adjacent work and eliminate evidence of restoration to greatest extent possible.

3.4 FIELD QUALITY CONTROL

- A. Quality Control Testing During Construction
 - 1. Allow the Engineer to inspect subgrades and fill layers before further construction work is performed.
 - 2. If in opinion of Engineer, based on field density testing and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no additional expense to the Owner.

END OF SECTION 31 23 23

Section 31 25 00 – Erosion & Sedimentation Control

PART 1 - GENERAL

1.1 WORK INCLUDES

- A. Installation of temporary and permanent erosion and sedimentation control systems.
- B. Installation of temporary and permanent slope protection systems.

1.2 RELATED WORK

- A. Specified Elsewhere:
 - 1. Section 02 41 00 – Demolition

1.3 ENVIRONMENTAL REQUIREMENTS

- A. Protect adjacent properties; any identified endangered or threatened species and/or critical habitat, any identified cultural or historic resources, and receiving water resources from erosion and sediment damage until final stabilization is achieved. All storm water controls and systems must be installed & functioning as designed and free of accumulated sediment and debris before final project approval.

PART 2 - REFERENCE TO STANDARDS

- 2.1 Missouri Department of Transportation (MoDOT): Standard Specifications for Highway, Latest Edition.**
- 2.2 Missouri Department of Natural Resources.**

PART 3 - PRODUCTS

3.1 MATERIALS

- A. Sod, and ground covers for the establishment of vegetation in accordance with Division 32.
- B. All erosion control products, sediment control devices, or materials for non-storm water BMPs as specified herein and on the Construction Drawings.
- C. Rolled erosion control products according to Erosion Control Technology Council (ECTC) standard specifications.
- C. Temporary mulches such as loose straw or wood cellulose.
- E. Temporary and permanent outfall structures as specified on the drawings.

3.2 SUBMITTALS

- A. Contractor shall submit shop drawings or material certifications for all manufactured erosion and sediment control materials.

PART 4 - EXECUTION

4.1 PREPARATION

- A. Review the drawings and Storm Water Pollution Prevention Plan.
- C. Conduct storm water pre-construction meeting with Site Contractor, all ground-disturbing Sub-contractors, site engineer of record or their representative who is familiar with the site, and state or local agency personnel if available.
- D. Revise Erosion Control Plan as necessary to address potential pollution from site identified after issuance of the Erosion Control Plan at no additional cost to owner.

4.2 EROSION AND SEDIMENTATION CONTROL AND SLOPE PROTECTION IMPLEMENTATION

- A. Place erosion and sediment control systems in accordance with the drawings or as may be dictated by site conditions in order to maintain the intent of the specifications and permits.
- B. Site Maps shall be corrected or modified as site conditions change. Contractor must obtain approval from Owner's Engineer prior to modifying or substituting Best Management Practices. Changes during construction shall be noted in the site plans.
- C. Owner has authority to limit surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and embankment operations and to direct Contractor to provide immediate permanent or temporary pollution control measures.
- D. Maintain erosion and sedimentation control systems as dictated by site conditions, indicated in the construction documents, or as directed by governing authorities or Owner to control sediment until final stabilization. Contractor shall respond to maintenance or additional work ordered by Owner or governing authorities immediately, but in no case, within not more than 48 hours at no additional cost to the Owner.
- E. Contractor shall incorporate permanent erosion control features, permanent slope stabilization, and vegetation into project at earliest practical time to minimize need for temporary controls.
- F. Permanently stabilize cut and fill slopes as construction proceeds to extent considered desirable and practical.
- G. Disturbed areas that will not be graded or actively worked for the time frame established in the plans, shall be temporarily stabilized as work progresses with vegetation or other acceptable means in accordance with Division 32 or as otherwise shown on the plans unless otherwise specified in the Contract Documents. In the event it is not practical to seed areas, slopes must be stabilized with mulch and tackifier, bonded fiber matrix, netting, blankets or other means to reduce the erosive potential of the area.
- H. Contractor shall adhere to all the terms and conditions as shown on the plans and contained in the Missouri Department of Natural Resources General Permit and SWPPP.
- I. Contractor shall provide a qualified personnel, in accordance with the attached SWPPP, to inspect disturbed areas of the construction site that have not been finally stabilized, as required by the Missouri Department of Natural Resources General Permit, at least once every seven (7) calendar days and within twenty-four (24) hours of the end of a storm that is 0.5 inches or greater or equivalent snowfall.

END OF SECTION 31 25 00

SECTION 32 05 23- CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Sections:
 - 1. 312000 – EARTH MOVING

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixture: For each concrete mixture.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement.
- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

1.3 INFORMATION SUBMITTALS

- A. Welding certificates.
- B. Material certificates.
- C. Material test reports.
- D. Floor surface flatness and levelness measurements.

1.4 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.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
 - 2. Manufacturer shall provide concrete mix designs stamped and sealed by a licensed professional Engineer licensed in the State of Arkansas.
- B. Testing Agency Qualifications: An independent agency, approved by Owner and Engineer qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Testing Agency shall be managed by a licensed professional engineer licensed in the State of Arkansas.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."
- D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- E. Concrete Testing Service: Engage and provide a qualified independent testing agency to perform material evaluation tests and to sample and test concrete mixtures.
- F. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 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. 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.

2.2 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
1. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class I or Class II, as approved, zinc coated after fabrication and bending.
 2. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.
- C. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.
- D. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
- E. Galvanized-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from galvanized-steel wire into flat sheets.
- F. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain or deformed steel, as approved.
- G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
1. Portland Cement: ASTM C 150, Type I or Type II gray. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F or C.

b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal Weight Aggregates: ASTM C 33, graded.

1. Maximum Coarse-Aggregate Size: 1 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M and potable.

2.4 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

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

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

2.5 WATERSTOPS

- A. Flexible Rubber Waterstops: CE CRD-C 513, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
- B. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.
- C. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
- D. Self- Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.
- E. Self- Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.

2.6 VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
- B. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.

2.7 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water. Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, non-dissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.
- G. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
 - 1. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- H. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
 - 1. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

2.9 CONCRETE MIXTURES

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Concrete mixture designs shall be stamped and signed by a registered professional Engineer registered in the State of Arkansas.
- B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
- C. Admixtures: Use admixtures with approval from Engineer and according to manufacturer's written instructions.
 - 1. Use water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

D. Proportion normal-weight concrete trail and pavement mixture as follows:

1. Minimum Compressive Strength: 3500 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 5.0 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.

E. Proportion normal-weight concrete bridge pier, abutment and structure mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 5.0 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.

2.10 FABRICATING REINFORCEMENT

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

2.11 CONCRETE MIXING

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

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

PART 3 - EXECUTION

3.1 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. Chamfer exterior corners and edges of permanently exposed concrete.

3.2 EMBEDDED ITEMS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.3 VAPOR RETARDERS

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.5 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
- E. Waterstops: Install in construction joints and at other joints indicated according to manufacturer's written instructions.

3.6 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. Concrete shall not be placed on top of mud, standing water, ice, trash, debris or anything other than the specified subbase material.
- C. 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.
- D. Cold-Weather Placement: Comply with ACI 306.1.
- E. Hot-Weather Placement: Comply with ACI 301

3.7 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces exposed to public view.
- C. Rubbed Finish- Apply the following to smooth-formed finished as-cast concrete where indicated:
 - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 - 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
 - 3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 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. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
 - 1. Apply scratch finish to surface indicated.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surface indicated.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of

trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surface indicated.
 2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch.
- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated. While concrete is still plastic, slightly scarify surface with a fine broom.
1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

3.9 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h 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, by one or a combination of the following methods:
1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer [unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project].
 4. 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.

3.10 CONCRETE SURFACES

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

3.11 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Engage and provide a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Sample concrete materials for slump, temperature and strength testing as required by ACI 301.
- C. Provide one (1) set of concrete tests for each 50 cubic yards of material or fraction thereof.
- D. Concrete test samples shall include four concrete cylinders for strength testing; one to be tested at 7 day, two to be tested at 28 day, and one spare to be tested at 56 days as required.

END OF SECTION 32 05 23

SECTION 32 11 23 – AGGREGATE BASE COURSES

PART 1 – GENERAL

1.1 WORK INCLUDES

- A. Furnish, place and compact an aggregate base course under the proposed pavements to the depths and at the locations shown on the plans.

1.2 RELATED WORK

- A. Specified elsewhere:
 - 1. Section 31 23 16 – Excavation.
 - 2. Section 31 23 23 – Fill.
 - 3. Section 31 32 00 – Soil Stabilization.
 - 4. Section 32 12 16 – Asphalt Paving.
 - 5. Section 32 13 13 – Concrete Paving.

1.3 REGULATORY REQUIREMENTS

- A. Conform to the applicable portions of Section 304 of the Missouri Department of Transportation (MoDOT): Standard Specifications for Highway Construction, including all Supplemental Specifications and Recurring Special Provisions.

1.4 SUBMITTALS

- A. Submit gradation and certification of material that is to be used to Engineer for review.
- B. Submit name of material supplier.
- C. Submit copies of Standard Proctor Density Test results to Engineer a minimum of twenty-four (24) hours prior to paving.

1.5 QUALITY ASSURANCE

- A. Compaction Testing
 - 1. Standard Proctor Density Testing and Compaction Testing of all aggregate base courses will be performed by the Contractor's testing service, using Proctor information furnished by the Contractor.
 - 2. If, in opinion of Engineer, based on testing service reports and inspection, subgrade or fills, which have been graded or placed on-site are below specified density, provide additional compaction and testing at no additional expense to the Owner.
 - 3. When, during progress of work, tests indicate that compacted materials will not meet specifications, remove defective work, replace and retest at no additional cost to the Owner.
 - 4. Ensure that all compacted subbases are tested before proceeding with placement of surface materials.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Type 5: Material used for aggregate base course shall be in accordance with the Missouri Department of Transportation (MoDOT), Standard Specification 1007. MoDOT's gradation Type 5 will be required for all impervious paved surfaces unless otherwise approved by the Engineer.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Verify existing subgrade has been compacted and prepared and is dry and that all gradients and elevations are correct.

3.2 PREPARATION

- A. Correct any irregularities in gradient and elevations by scarifying, reshaping and re-compacting.
- B. Do not place fill on soft, muddy or frozen surfaces.
- C. Prior to placement of aggregate base course, the subgrade shall be prepared in accordance with Section 209 of the MoDOT Standard Specifications and shall be proofrolled to detect areas of insufficient compaction. Proofrolling shall be accomplished by making a minimum of 2 complete passes with a fully loaded tandem-axle dump truck with a maximum weight of 20 tons, or approved equal, in each of 2 perpendicular directions. The Contractor shall document all proofroll procedure and results. Areas of failure shall be stabilized in accordance with Section 31 32 00 – Soil Stabilization.
- D. Maintain moisture content of the subgrade between -2% and +3% optimum at the time of paving.

3.3 AGGREGATE PLACEMENT

- A. Spread aggregate over the prepared subgrade to the lines and grades shown in the plans in accordance with MoDOT's Standard Specifications.
- B. Compact base material to not less than 97% standard proctor.
- C. Water shall be added as required by the Engineer to obtain satisfactory compaction.

3.4 TOLERANCES.

- A. Top surface of aggregate: Plus or minus 1/4 in.

3.5 SURPLUS MATERIALS

- A. Remove surplus materials from site.

END OF SECTION 32 11 23

SECTION 32 13 13 - CONCRETE PAVEMENT

PART 1 GENERAL

1.1 DESCRIPTION

- A. Furnish and construct all exterior portland cement concrete as shown on Drawings and herein specified.

1. Work to be included under this Section shall consist of the following:

- a. Driveways, fire access lanes, dumpster approach, sidewalks, and any concrete pavement specified on the drawings.

- B. Related Work Specified Elsewhere:

1. Section 312000: Earthwork
2. Section 321216: Asphalt Pavement

1.2 QUALITY ASSURANCE

- A. Qualifications of Installers:

1. Provide at least 1 person at all times during execution of this portion of Work and who is thoroughly familiar with the type of materials being installed and is directly responsible for all Work performed under this Section.

- B. Requirements of Regulatory Agencies:

1. It is Contractor's responsibility to comply with the requirements of the regulatory agencies, including the purchase of any permits at their own expense.

- C. Construction Tolerances:

1. Vertical alignment shall not vary more than 1/8 inch from the edge of a 10-foot straight edge.
2. Horizontal alignment shall not vary more than 1/2 inch from the plan alignment for pavement.
3. Concrete thickness shall not be less than specified.
4. Reinforcing bars shall be placed to the following tolerances:

- a. Clear distance to formed surface, plus or minus ¼ inch.
- b. Sheared length, plus or minus 1 inch.
- c. Concrete cover on top bars in slabs and beams 8 inches deep or less, 2 inches plus or minus 1/4 inch.
- d. Concrete cover on top bars in members 8 inches to 24 inches deep, 2 inches plus or minus 1/2 inch.
- e. Crosswise or lengthwise spacing, plus or minus 2 inches provided minimum spacing and cover requirements are not violated.

D. Referenced Standards:

1. The current editions of the following American Concrete Institute (ACI) publications shall govern all Work performed hereunder, unless otherwise specified:

- a. Recommended Practice for Concrete Floor and Slab Construction - ACI 302.
- b. Recommended Practice for Hot Weather Concreting – ACI 305.
- c. Recommended Practice for Cold Weather Concreting - ACI 306.
- d. Recommended Practice for Construction of Concrete Pavements and Concrete Bases - ACI 316.
- e. Building Code Requirements for Reinforced Concrete - ACI 318.

E. Design Criteria:

1. Contractor shall employ an approved independent materials testing laboratory and pay for the service of setting up the design mixes and to analyze the fine and coarse aggregate for the various uses of concrete utilized on the project. Design mixes shall be in accordance with the previously cited ACI 318 publication and in compliance with this Specification. The proposed mixes shall be submitted to OWNER for approval prior to placing of any concrete. The approved mixes established by the laboratory shall be used in the Work as long as the characteristics of the ingredients remain unchanged. If any significant change is made in the ingredients, new mixes shall be prepared and submitted to OWNER for approval.

2. Concrete shall consist of a minimum 28 day compressive design strength of 4,000 psi using portland cement, aggregate, air entraining admixture, water and an

air content ranging from 5 to 7 percent. Slump of concrete shall have a range of 2 to 4 inches.

a. If any of the conditions vary from those as described, Contractor shall submit a revised mix design prepared by the testing laboratory along with a written request for the variance desired to OWNER for their consideration and approval.

b. Concrete for portions of the structure required to be watertight, such as water storage, pumpstation wetwells and waste treatment tanks, shall be air-entrained and have a water-cement ratio not exceeding 0.48.

c. Admixtures shall be used only with the approval in writing by OWNER. All admixtures shall be used in accordance with the manufacturer's instructions and shall be added at the plant. Calcium chloride shall not be used as an admixture.

d. Mix designs shall be based on Type I cement. Type III (high early) cement or any other types of cement shall be used only when approved in writing by OWNER. When high-early cement is used, the 7-day strength test shall exceed the specified 28-day strength tests.

1.3 SUBMITTALS

A. Product Data:

1. Prepare and submit product data for OWNER'S approval. Product data shall include manufacturer's recommended installation instructions.

B. Samples:

1. If requested by OWNER, submit samples for approval of proposed materials.

C. Certification:

1. Submit 3 copies of certification of material compliance as requested by OWNER.

D. Delivery Tickets:

1. Submit a delivery ticket with each truck load of concrete delivered which indicates OWNER'S design mix, truck number, project number, Contractor, ready mix producer, time of batching and total yards of concrete.

E. Test Reports and Design Mixes:

1. Submit 3 copies of design mixes and material test reports to OWNER.

PART 2 PRODUCTS

2.1 MATERIALS

A. Form Material:

1. Form material shall be either sound lumber or steel, free of defects and variations in dimensions. The sides of all lumber shall be surfaced and matched to prevent mortar leakage. Metal forms shall be of standard manufacture and need not be new, but shall be free from rust and dirt. Metal forms shall be flat and true to line without punctures. All form material shall be sized and of strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal of same.

a. Rigid forms are to be utilized on tangent alignment and curves having a radius of 150 feet or greater.

b. Curved forms shall be utilized on the curved Work with a radius of 150 feet or less, and shall consist of flexible spring steel or laminated lumber.

B. Reinforcement Materials:

1. Reinforcing bars and dowels shall be of new billet steel conforming to ASTM A615, Grade 60 (60,000 psi yield). Sizes of bars shall be as indicated on Drawings or herein specified.

a. Dowel bars when used for contraction and expansion joints shall be smooth steel bars coated with a thin uniform coating of liquid asphalt (MC-250) or grease on 1/2 the length of the bar plus 2 inches. In addition, dowel bars for expansion joints shall be furnished with end caps designed with one end closed, a minimum length of 3 inches and be positioned to allow bar movement of not less than 1 inch.

b. Dowel bar assemblies may be permitted if fabricated to the width of the pavement section.

c. Tie bars for control, longitudinal and construction joints shall be deformed bars.

C. Concrete Materials:

1. Portland cement shall conform to ASTM C150.

a. Cement shall be a low alkali cement (Type I) containing not more than 0.6 percent by weight of tri-sodium silicate oxide.

2. Coarse aggregate shall conform to Size 57 grade requirements of Table 2 of ASTM C33 standard.

3. Fine aggregate shall conform to ASTM C33 with fineness modulus not to vary more than 0.20 from value assumed in design mix.

4. Water shall be potable, clean and free from deleterious amounts of acid, alkali or organic material.

D. Admixtures:

1. Air entraining agent shall conform to ASTM C260 and shall be added at the mixer.

2. Water reducing agents, (such as super plasticizers), retarding agents, accelerating agents and all other admixtures, shall require approval by OWNER and if used, shall conform to ASTM C494. In no case shall admixtures be permitted as substitute for cement content specified, unless approved by OWNER.

E. Expansion Joint Material:

1. Joint filler material shall consist of a non-extruding standard bituminous bound type "Sealtight Asphalt Expansion Joint" as manufactured by W.R. Meadows, Inc., Elgin, Illinois or OWNER approved equal.

a. Material shall conform to ASTM D994.

2. Joint filler material shall consist of preformed non-extruded bituminous bound type "Sealtight-Fibre Expansion Joint" as manufactured by W.R. Meadows, Inc., Elgin, Illinois; "Code 1390" as manufactured by W.R. Grace Company, Cambridge, Massachusetts or OWNER approved equal.

a. Material shall conform to ASTM D1751.

b. Material shall be 1/2 inch thick, unless otherwise noted, of widths equal to slab thickness less 1/2 inch or as otherwise indicated.

3. Joint sealant shall be a single component, polyurethane type "Sikaflex-la" as manufactured by Sika Chemical Corporation, Lyndhurst, New Jersey or OWNER approved equal. Color as selected by OWNER.

F. Curing Materials:

1. Kraft paper shall be waterproof and nonstaining "Sisalkraft 5K-10" conforming to ASTM C171.

2. Polyethylene film shall be white opaque sheet or roll material not less than 0.006 inch thick (6 mil) conforming to AASHTO-M171.

3. Contractor may at their option use a liquid curing compound for surfaces that will not receive treating oil or waterproofing membrane. Liquid curing compound shall conform to ASTM C309 and shall consist of the following:

a. Type 1D, translucent with fugitive dye.

b. Type 2, white pigmented, Class B (vehicle solids restricted to all resin).

2.2 PRODUCTION

A. Concrete shall be ready-mixed, and shall be batched, mixed and transported in accordance with "Specification for Ready-Mixed Concrete" ASTM C94. The production plant equipment and facilities shall meet the requirements of the National Ready Mixed Concrete Association.

PART 3 EXECUTION

3.1 JOB CONDITIONS

A. Hot Weather Conditions:

1. The following precautions shall be adhered to:

a. Reject concrete mixture having temperature of 85°F or greater.

b. Pre wet subgrade.

c. Crushed or flaked ice may be utilized in reducing temperature of mixture.

d. If necessary, reduce temperature of reinforcing steel with wet burlap.

e. Reduce mixing time (agitating time) in truck to 45 minutes.

f. During periods of high winds, shelter windward side with adequate wind breaks.

g. Apply no chemical retarder to finished surface unless permission is granted in writing by OWNER.

B. Cold Weather Conditions:

1. When ambient temperature is 40°F or less, the following precautions are to be adhered to:

a. Subbase shall not be frozen.

b. Concrete mixture delivered at Worksite shall be 55°F (minimum), 85°F (maximum).

c. No calcium chlorides, salts or other chemical accelerators shall be permitted, unless otherwise acceptable in writing by OWNER.

d. Concrete surface shall be maintained at a minimum of 50°F with appropriate thermal insulation for a period of 7 days (normal concrete), 3 days (high early-strength concrete).

e. Refer to previously cited ACI 306 for minimum thickness of thermal protection required.

f. Any concrete that has frozen or disintegrated as a result of freezing shall be removed and replaced at Contractor's expense.

3.2 SUBGRADE PREPARATION

A. Fine grade and compact subgrade to the plan cross section. Compaction shall be as specified in Section 312000 of this Specification or as indicated on the Drawings.

B. After compaction, cut-out soft spots and unstable areas in the subgrade and fill with select fill material and compact as specified in Section 312000.

3.3 GRANULAR BASE

A. Construct the select fill and granular base as shown on Drawings on the prepared subgrade after the final shaping and compacting of the subgrade is completed.

B. Compact as specified base in Section 312000 of this Specification.

3.4 FORM CONSTRUCTION

- A. Forms shall have the strength and rigidity, regardless of material, such that when they are set in place and braced, they will withstand weight of equipment and weight of concrete without settlement or lateral displacement.
- B. Keyway forms in the edge of pavement slabs and at construction joints shall be constructed to the dimensions shown on Drawings. Wood keyway forms, if used, shall be bolted or nailed to the side forms. Metal keyway forms shall be fixed or held rigidly in place by staking or other OWNER approved method.
- C. Forms shall be coated prior to the placement of concrete, with a nonstaining form release agent. Wooden form may be prewetted with water. No standing water, adjacent to forms, shall be permitted.

3.5 REMOVAL OF FORMS

- A. Forms for slabs on grade shall not be removed earlier than 12 hours after the placement of concrete has been completed. Within 24 hours of form removal backfill adjacent to the pavement shall be completed.
- B. Forms supporting the weight of concrete shall not be released until the concrete has reached its specified 28-day strength. Minimum time elapse after casting and before the false Work supports are released shall be 8 days for spans up to 96 inches center to center of supports, plus 1 additional day for each 12 inches of increase in span length over 84 inches up to 14 days for span of 14 feet and over. Such time period shall be exclusive of those time intervals during which the concrete surface temperature is below 40°F. If temperature remains below 40°F during the casting and curing period no forms shall be removed until approved field tests indicating adequate concrete strength have been provided.

3.6 REINFORCEMENT PLACEMENT

- A. Tie bars, reinforcement bars and dowel bars shall be clean, free from rust and shall be placed on adequate supports in locations as shown on Drawings. Provide the following minimum thickness of concrete cover:
 - 1. Concrete deposited on ground: 3 inches
 - 2. Formed surfaces against ground: 1-1/2 inches
 - 3. Beams, girders and columns: 1-1/2 inches
 - 4. Slabs, walls and joists: 1 inch

5. Clear distance between parallel bars: 1 inch or nominal bar distance
 6. For No. 6 bars or larger: 2 inches
 7. No broken brick, block or concrete shall be permitted as reinforcement supports.
- B. Welded steel wire fabric shall be placed free from rust, kinks and bends and shall be cut in such a way that the overlap measured between outermark cross wires of each fabric sheet is not less than 2 inches. The fabric shall be cut at contraction joints. It shall be supported by a layer of fresh concrete placed to the depth of the mesh shown on Drawings, followed by placement of the upper layer of concrete.

3.7 CONCRETE PLACEMENT

- A. Place concrete to required depth and width to form a continuous mass requiring a minimum of rehandling. Concrete adjacent to side forms and fixed structures shall be consolidated by means of portable vibrators or by mechanical means with the use of hand spading. Vibrators shall not be used to move concrete horizontally.
- B. If it is necessary to place a construction joint prior to a contraction joint, the distance between the construction joint and the previous contraction joint shall not be less than 60 inches.
- C. Automatic machine may be used for curb and gutter placement at Contractor's option, if acceptable to OWNER. If machine placement is to be used, submit revised mix design and laboratory test results, which meet or exceed the minimum herein specified. Machine placement must produce curbs and gutters to the required cross-section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified.

3.8 JOINTS

- A. General:
1. Construct expansion, contraction and construction joints with face perpendicular to surface of concrete.
 2. Where joining existing structures, match existing contraction or expansion joints.
- B. Expansion Joints:

1. All fixed objects, such as buildings and structures or pavement, sidewalks or curb intersections shall be separated by a 1/2 inch expansion joint placed at the full depth of the concrete thickness. Expansion joints, in addition to the above, shall be placed at 60 foot intervals in the following:

a. Concrete curb and gutter

b. Concrete walk

2. For pavement construction, place expansion joints as shown on Drawings.

C. Contraction Joints:

1. Contraction joints shall be placed at the following intervals and dimensions or as shown on Drawings:

a. Concrete curb and gutter – 10 feet; 1/8 inch wide by 1 1/2 inch depth.

b. Concrete walk – 10 feet; 1/8 inch wide by 1/4 the depth of concrete.

2. Cut plastic concrete with appropriate tool to specified depth. Finish edges with 1/4 inch radius tool.

3. Saw-cut joints to specified width and depth on hardened concrete as soon as concrete has hardened sufficiently to prevent raveling or damage to the joint.

D. Joint Sealer:

1. Apply joint sealer to a clean and dry expansion or contraction joint if specified to a point approximately 1/4 inch below the top surface. Where oil treatment is specified, joint sealer shall be applied prior to application of the oil.

3.9 CONCRETE FINISH

A. After initial strike-off and floating, and prior to finishing, test surface with 10-foot straightedge. Correct irregularities prior to final finishing operations.

B. Apply the following surface finish after surface sheen or excess moisture has disappeared:

1. Apply steel trowel finish followed by stiff-bristled broom drawn across concrete surfaces, perpendicular to line of traffic:

a. Sidewalk

b. Concrete pavement

c. Curb and gutter

3.10 CONCRETE CURING AND PROTECTION

- A. Cure concrete surfaces for 7 days (normal concrete) and for 3 days (high early-strength concrete), using appropriate means of protection as previously cited in ACI 305 and ACI 306.
- B. Curing methods shall consist of one of the following:
 - 1. Keep concrete surface continuously wet by ponding with water.
 - 2. Apply moisture proof fabric to entire area lapping joints and edges at least 3 inches. Tape interior joints and weight edges down with sand or other approved material.
 - 3. Apply liquid membrane curing compound to the finished surface in a 2 coat continuous operation with second application applied transversely to the direction of the first application, and in accordance with the manufacturer's directions. Replace damaged areas with equal applications of membrane using compound. Liquid membrane curing compound shall not be permitted where the surface will be subjected to an application of waterproof coatings, bonding agents, treating oil or paint.

3.11 TESTING AND EVALUATION

- A. Concrete materials and operations shall be tested and inspected as the Work progresses, by an independent testing laboratory. Contractor shall furnish any necessary labor who is familiar with methods of sampling and shall assist the testing agency in obtaining and handling samples, and for safe storage and proper curing of concrete test specimens on Worksite.
- B. Mold and cure three standard 6-inch diameter specimens from each sample in accordance with ASTM C31. Compressive strength test specimens shall be in accordance with ASTM C39. Two specimens shall be tested at 28 days for acceptance and one shall be tested at 7 days for information. The acceptance test results shall be the average of the strengths of the two specimens tested at 28 days. If one specimen in a test manifests evidence of improper sampling, molding or testing, it shall be discarded and the strength of the remaining cylinder shall be considered the test result. Should both specimens in a test show any of the above defects, the entire test shall be discarded. When high-early strength concrete is used, the first specimen shall be tested at 3 days; the remaining two at 7 days.

- C. Make at least one strength test for each 50 cubic yards, or fraction thereof, of each mix design of concrete placed in any one day.
- D. Determine slump of the concrete sample for each strength test and whenever consistency of concrete appears to vary, using standard slump cone as per ASTM C143.
- E. The testing laboratory shall report all test and inspection results to OWNER, OWNER'S Engineer, and Contractor immediately after they are performed. All concrete test reports shall include name of job, date of placement, date of test, batch mix design, slump and the exact location in the Work at which the batch represented by the test was deposited.
- F. All costs necessary to prepare concrete test cylinders, make tests and furnishing of written reports shall be borne by the Contractor.

3.12 DEFECTIVE WORK

- A. When tests and inspections of the aggregate base and/or concrete Work indicate non-compliance with the Specification, Contractor and OWNER shall mutually agree on the number and location of additional tests to define and/or verify the deficiency. If the average of the tests for a given area indicate non-compliance the area is considered defective and Contractor shall:
 - 1. Remove and replace defective Work at no cost to OWNER;
 - 2. Correct the Work at no cost to OWNER in a manner acceptable to OWNER;
 - 3. Give OWNER a credit towards the Contract Price if it is acceptable to OWNER;
 - 4. If Work is found to be in noncompliance, Contractor shall pay for the defective area removal and replacement, and the tests and inspection costs; or
 - 5. If Work is found to be in compliance, OWNER shall pay for tests and inspection costs.

END OF SECTION

SECTION 32 13 73

CONCRETE PAVING JOINT SEALANTS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Section Includes:

1. Cold-applied joint sealants.
2. Hot-applied joint sealants.
3. Joint-sealant backer materials.
4. Primers.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- ###### A. Product Data: For each type of product.
- ###### B. Samples: For each kind and color of joint sealant required.
- ###### C. Paving-Joint-Sealant Schedule: Include the following information:
1. Joint-sealant application, joint location, and designation.
 2. Joint-sealant manufacturer and product name.
 3. Joint-sealant formulation.
 4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

- ###### A. Product certificates.

PART 2 PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 COLD-APPLIED JOINT SEALANTS

- A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type NS.
- B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type SL.
- C. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.
- D. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.
- E. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade P, Class 25, for Use T.

2.3 HOT-APPLIED JOINT SEALANTS

- A. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I.
- B. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I or Type II.
- C. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I, II, or III.
- D. D 6690, Type IV.

2.4 JOINT-SEALANT BACKER MATERIALS

- A. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- B. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
- C. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.5 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 EXECUTION

3.1 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Cleaning of Joints: Clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
- C. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer.
- D. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.
- E. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of joint-sealant backings.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
 - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- F. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:
 - 1. Place joint sealants so they fully contact 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.
- G. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to

eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- H. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.
- I. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

END OF SECTION

SECTION 321443 - POROUS UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete grid pavers [**with aggregate fill**].
2. Solid concrete pavers with openings between pavers filled with aggregate.
3. Aggregate setting bed for pavers.

Delete subparagraph below if edge restraints are specified in Section 321400 "Unit Paving."

4. Edge restraints.

1.2 ACTION SUBMITTALS

A. Product Data: For materials other than aggregates.

B. Sustainable Design Submittals:

C. Sieve Analyses: For aggregate materials, according to ASTM C 136.

D. Samples:

1. Full-size units of each type of unit paver indicated.
2. Exposed edge restraints.
3. Aggregate fill.
4. Aggregate setting bed materials.

1.3 QUALITY ASSURANCE

If "Mockups" Paragraph below is retained, indicate location, size, and other details of mockups on Drawings or by inserts. Revise wording if only one mockup is required.

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

Retain subparagraph below if the intention is to make an exception to the default requirement in Section 014000 "Quality Requirements" for demolishing and removing mockups.

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

PART 2 - PRODUCTS

Manufacturers and products listed in SpecAgent and Masterworks Paragraph Builder are neither recommended nor endorsed by the AIA or ARCOM. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

2.1 CONCRETE UNIT PAVERS

- A. <Double click to insert sustainable design text for regional materials.>

"Concrete Grid Pavers" Paragraph below applies to most standard grid paving units. ASTM C 1319 requires compressive strength of 5000 psi (35 MPa) and minimum thickness of 3-1/8 inches (80 mm). ASTM C 1319 contains no requirement for freeze-thaw resistance, only a requirement for durability based on three years' "proven field performance" in "the same general type of environment, temperature range, and traffic volume."

- B. Concrete Grid Pavers: Grid paving units complying with ASTM C 1319, made from normal-weight aggregates.

Retain one thickness from options in "Thickness" Subparagraph below. Minimum thickness for pavers complying with ASTM C 1319 is 3-1/8 inches (80 mm). If grass or ground covers are used with pavers, units should be thick enough to provide adequate depth of soil fill.

1. Thickness: **[3-1/8 inches (80 mm)] [3-1/2 inches (90 mm)] [4 inches (100 mm)] <Insert dimension>.**
2. Face Size and Shape: **[As indicated] <Insert size and shape>.**
3. Opening Percentage: **<Insert number>percent.**
4. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.**

"Solid Concrete Pavers for Porous Paving" Paragraph below applies to standard solid concrete pavers that are shaped to provide drainage holes in the assembled pavement. Units complying with paragraph below will not provide as much open area as grid paving units complying with paragraph above and do not comply with requirements for porous paving for LEED-NC, LEED-CS, or LEED for Schools Credit SS 7.1, but they may help comply with LEED-NC, LEED-CS, or LEED for Schools Credit SS 6.1 and Credit SS 6.2. ASTM C 936/C 936M limits length-to-thickness ratio to no more than 4:1 (to provide interlocking effect); it limits face area to no more than 101 sq. in. (0.065 sq. m) and requires compressive strength of 8000 psi (55 MPa). ASTM C 936/C 936M requires units to be freeze-thaw resistant but gives manufacturer the option of either "proven field performance," which it does not define, or laboratory tests according to ASTM C 67. Revise paragraph below if units made from lightweight aggregates are required.

- C. Solid Concrete Pavers for Porous Paving: Solid interlocking paving units of shapes that provide openings between units, complying with ASTM C 936/C 936M[, **resistant to freezing and thawing when tested according to ASTM C 67**], and made from normal-weight aggregates.

Retain one thickness from options in "Thickness" Subparagraph below. If grass or ground covers are used with pavers, units should be thick enough to provide adequate depth of soil fill.

1. Thickness: **[2-3/8 inches (60 mm)] [3-1/8 inches (80 mm)] [3-1/2 inches (90 mm)] [4 inches (100 mm)] <Insert dimension>.**
2. Face Size and Shape: **[As indicated] <Insert size and shape>.**
3. Opening Percentage: **<Insert number>percent.**
4. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.**

2.2 ACCESSORIES

Delete this article if no edge restraints or if these items are specified in other Sections. Other sizes and configurations are available besides those indicated below. See manufacturers' catalogs.

Second option in "Plastic Edge Restraints" Paragraph below describes Pave Tech's "Industrial" edging. Plastic edge restraints are installed below grade, so color is not a concern.

- A. Plastic Edge Restraints: Triangular PVC extrusions, [**1-3/4 inches (45 mm) high by 3-1/2 inches (90 mm) wide**] [**3-1/8 inches (80 mm) high by 9-1/2 inches (240 mm) wide**], designed to serve as edge restraints for unit pavers; rigid type for straight edges and flexible type for curved edges, with pipe connectors and 3/8-inch- (9.5-mm-) diameter by 12-inch- (300-mm-) long steel spikes.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

- B. Steel Edge Restraints: Painted steel edging, [**3/16 inch (4.8 mm) thick by 4 inches (100 mm) high**] [**1/4 inch (6.4 mm) thick by 5 inches (125 mm) high**], with loops pressed from or welded to face to receive stakes at 36 inches (900 mm) o.c., and with steel stakes 15 inches (380 mm) long for each loop.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

Retain "Color" Subparagraph below if edge restraints are installed above grade and color is a concern.

2. Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] **<Insert color>**.

Aluminum edge restraints are generally installed below grade, so color is usually not a concern. Aluminum edging normally has a mill finish.

- C. Aluminum Edge Restraints: [**Straight, 1/8 inch (3.2 mm) thick by 4 inches (100 mm) high**] [**Straight, 3/16 inch (4.8 mm) thick by 4 inches (100 mm) high**] [**L-shaped, 1/8 inch (3.2 mm) thick by 1-3/8 inches (35 mm) high**] [**L-shaped, 3/16 inch (4.8 mm) thick by 2-1/4 inches (57 mm) high**] extruded-aluminum edging, with loops

pressed from face to receive stakes at 12 inches (300 mm) o.c., and with aluminum stakes 12 inches (300 mm) long for each loop.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.3 AGGREGATE SETTING-BED MATERIALS

- A. <Double click to insert sustainable design text for aggregate and soil.>

"Graded Aggregate for Subbase" and "Graded Aggregate for Base Course" paragraphs below are examples of aggregate types and gradations that could be used where two layers are placed beneath leveling course. For heavy-duty applications, consult highway-department requirements and revise to suit Project. See the Evaluations.

First option in "Graded Aggregate for Subbase" Paragraph below is for light-traffic uses; second is for stormwater infiltration and storage; third is for heavy-duty applications. Delete paragraph if subbase is not required.

- B. Graded Aggregate for Subbase: Sound crushed stone or gravel complying with **[ASTM D 448 for Size No. 57] [ASTM D 448 for Size No. 5] [ASTM D 2940/D 2940M, subbase material] [requirements in Section 312000 "Earth Moving" for subbase material]**.

First option in "Graded Aggregate for Base Course" Paragraph below is for light-traffic uses; second is for stormwater infiltration and storage; third is for heavy-duty applications.

- C. Graded Aggregate for Base Course: Sound crushed stone or gravel complying with **[ASTM D 448 for Size No. 8] [ASTM D 448 for Size No. 57] [ASTM D 2940/D 2940M, base-course material] [requirements in Section 312000 "Earth Moving" for base-course material]**.

Generally, retain "Sand for Leveling Course" or "Soil Mix for Leveling Course" Paragraph below for grid paving units planted with grass or ground cover. Soil mix will not drain as well as sand, and may not support heavy loads as well as sand, but it will provide a better environment for plants.

- D. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33/C 33M for fine aggregate.

- E. Soil Mix for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33/C 33M for fine aggregate blended with planting soil <Insert drawing designation> according to [Section 329113 "Soil Preparation."] [Section 329115 "Soil Preparation (Performance Specification)."] Use blend consisting of [1/2 sand and 1/2 planting soil mix] [2/3 sand and 1/3 planting soil mix] <Insert proportions>.

"Graded Aggregate for Leveling Course" Paragraph below is recommended instead of "Sand for Leveling Course" or "Soil Mix for Leveling Course" Paragraph above for pavers used with aggregate fill. No. 8 stone is 1/2 inch (12.5 mm) and smaller; No. 9 is 3/8 inch (9.5 mm) and smaller.

- F. Graded Aggregate for Leveling Course: Sound crushed stone or gravel complying with ASTM D 448 for Size No. [8] [9].

Retain "Drainage Geotextile" Paragraph below if nonwoven geotextile is used between aggregate base and leveling course. Also retain for use below aggregate base and subbase if porous paving is intended to provide stormwater infiltration into subgrade. Geotechnical report may also include geotextile recommendations.

- G. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured according to test methods referenced:

Retain "Survivability" Subparagraph below if AASHTO M 288 survivability classification is required. Survivability classification rates a geotextile's ability to withstand installation stresses and is divided into three classes by AASHTO M 288. Class 2 is default class recommended by AASHTO M 288 for subsurface drainage applications. Revise to Class 1 if higher strength is required or to Class 3 if lower strength is permitted.

1. Survivability: Class 2; AASHTO M 288.

Requirements in "Apparent Opening Size," "Permittivity," and "UV Stability" subparagraphs below correspond to default values in AASHTO M 288 for Class 2 drainage geotextiles.

2. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D 4751.
3. Permittivity: 0.5 per second, minimum; ASTM D 4491.
4. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.4 FILL MATERIALS

Retain "Soil Fill for Porous Paving" Paragraph below for pavers planted with grass or ground cover.

- A. Soil Fill for Porous Paving: Planting soil <Insert drawing designation> according to [Section 329113 "Soil Preparation."] [Section 329115 "Soil Preparation (Performance Specification)."]

Retain "Aggregate Fill for Porous Paving" Paragraph below for solid concrete pavers and for grid paving units used without planting. No. 8 stone is 1/2 inch (12.5 mm) and smaller; No. 9 is 3/8 inch (9.5 mm) and smaller.

- B. Aggregate Fill for Porous Paving: Graded, sound, crushed stone or gravel complying with ASTM D 448 for Size No. [8] [9].

Retain "Color" Subparagraph below if a particular color is required.

- 1. Color: [As indicated] [Match Architect's sample].

Retain "Grass Seed" Paragraph below for grid paving units used with grass.

- C. Grass Seed: Comply with requirements in Section 329200 "Turf and Grasses."

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be structurally unsound or visible in finished work.
- B. Cut unit pavers with motor-driven masonry saw equipment[or a block splitter] to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

C. Tolerances:

1. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/16-inch (1.5-mm) unit-to-unit offset from flush.
2. Variation from Level or Indicated Slope: Do not exceed 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) or a maximum of 1/2 inch (13 mm).

- D. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

3.2 SETTING-BED INSTALLATION

Retain first paragraph below if compaction is not specified in Section 312000 "Earth Moving." Coordinate with that Section to ensure that compaction for subgrade under concrete pavers is correctly specified. Paragraph below is an example only; revise to suit Project.

- A. Compact subgrade uniformly to at least **[95]** <Insert number> percent of **[ASTM D 698]** **[ASTM D 1557]** laboratory density.

Revise overlap in first paragraph below to 24 or 36 inches (600 or 900 mm) for weak subgrade. Delete if geotextile is not required.

- B. Place drainage geotextile over prepared subgrade, overlapping ends and edges at least 12 inches (300 mm).
- C. Place aggregate **[subbase]** **[and]** **[base]**, compact by tamping with plate vibrator, and screed to depth indicated.

Retain first paragraph above or below or both unless subbase and base are specified in another Section. Retain above for light-traffic uses; retain below for heavy-duty applications. Delete subbase if not required. Paragraph below is an example only, although 100 percent compaction is usually easily achieved with highly granular materials used for base and subbase material with porous paving; revise to suit Project. ASTM D 1557 is generally used instead of ASTM D 698 for highly granular material when maximum compaction is required.

- D. Place aggregate [**subbase**] [**and**] [**base**], compact to [**100**] <Insert number> percent of ASTM D 1557 maximum laboratory density, and screed to depth indicated.

Retain first paragraph below if needed for open-graded subbase material to prevent base course from washing into subbase.

- E. Place drainage geotextile over compacted subbase, overlapping ends and edges at least 12 inches (300 mm).

Retain first paragraph below for open-graded base-course material to prevent leveling course from washing into base course.

- F. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches (300 mm).
- G. Place leveling course, and screed to a thickness of [**1 to 1-1/2 inches (25 to 38 mm)**] [**2 to 2-1/2 inches (50 to 64 mm)**] [**3 inches (76 mm)**] <Insert dimension>, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

3.3 PAVER INSTALLATION

- A. Set unit pavers on leveling course, being careful not to disturb leveling base. If pavers have lugs or spacer bars to control spacing, place pavers hand tight against lugs or spacer bars. If pavers do not have lugs or spacer bars, place pavers with a 1/16-inch- (1.6-mm-) minimum and 1/8-inch- (3.2-mm-) maximum joint width
- B. Compact pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf (16- to 22-kN) compaction force at 80 to 90 Hz.

Retain first two paragraphs below if porous paving is planted with grass. Retain first paragraph below if ground cover is used (ground covers are specified in Section 329300 "Plants").

- C. Place soil fill immediately after vibrating pavers into leveling course. Spread and screed soil fill level with tops of pavers. Vibrate pavers and add soil fill until porous

paving is filled to about 3/4 inch (19 mm) from top surface; remove excess soil fill if any.

- D. After filling pavers with soil, sow seed according to Section 329200 "Turf and Grasses," except sow seed at half the rate specified for seeding lawns. Sweep seed from surfaces of pavers into voids and water with fine spray.

Retain first paragraph below if aggregate fill is used.

- E. Place graded aggregate fill immediately after vibrating pavers into leveling course. Spread and screed aggregate fill level with tops of pavers.
- F. As work progresses, remove and replace pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

3.4 MAINTENANCE AND PROTECTION

Retain this article if porous paving is planted with grass or ground cover. Retain first paragraph below only if pavers are planted with grass. Maintenance of ground covers after planting is specified in Section 329300 "Plants".

- A. Water newly planted grass and keep moist until grass is established. Maintain grass that is planted in paving to comply with requirements in Section 329200 "Turf and Grasses."
- B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades for [60] <Insert number> days after planting.

END OF SECTION 321443

SECTION 32 31 19
DECORATIVE METAL FENCES AND GATES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Decorative aluminum fences and gates.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 31 23 16 - Excavation.

1.3 REFERENCE STANDARDS

- A. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2024.
- B. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- C. ASTM F2408 - Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets; 2016 (Reapproved 2023).
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to start of work of this section; require attendance by affected installers.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings:
 - 1. Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
 - 2. Foundation details, concrete design mix and reinforcing schedule for anti-ram barrier system.
- D. Samples: Submit two samples of fence panels, 12 inch by 12 inch in size illustrating construction and colored finish.
- E. Manufacturer's Installation Instructions: Indicate installation requirements, post foundation anchor bolt templates, and _____.
- F. Manufacturer's Qualification Statement.
- G. Installer's Qualification Statement.
- H. Manufacturer's Warranty.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- B. Installer Qualifications: Experienced with type of construction involved and materials and techniques specified and approved by fence manufacturer.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Store materials in a manner to ensure proper ventilation and drainage. Protect against damage, weather, vandalism and theft.

1.8 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide five year manufacturer warranty for _____.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Decorative Metal Fences and Gates:
 - 1. Basis-of-Design Product: Provide Blade Post Fence as manufactured by BOK MODern, Inc., www.bokmodern.com, or comparable product of other manufacturers approved by the Architect.

2.2 FENCES

- A. Fences: Complete factory-fabricated system of posts and panels, accessories, fittings, and fasteners; finished with electrodeposition coating, and having the following performance characteristics:
 - 1. Capable of resisting vertical load, horizontal load and infill performance requirements for fence categories defined in ASTM F2408.
- B. Aluminum: ASTM B221.
 - 1. Tubular Pickets, Rails and Posts: 6005-T5 alloy.
 - 2. Extrusions for Posts and Rails (Outer Channel): 6005-T5 alloy.
 - 3. Extrusions for Pickets and Rail (Inner Slide Channels): 6063-T5 alloy.
- C. Fasteners: ASTM A276/A276M, Type 302 stainless steel; finished to match fence components.

2.3 ALUMINUM FENCE

- A. Decorative Aluminum Fence System: Provide fence meeting the Test Load and Coating Performance requirements of ASTM F2408 for Industrial class.
 - 1. Fence Panels: 4 feet high by 6 feet long.
 - a. Panel Style: B21.
 - b. Posts: Manufacturer's standard tubes.
 - c. Rails: Manufacturer's standard channels.
 - d. Pickets: Manufacturer's standard; tubes.
 - 1) Style: _____.
 - 2) Integrally Formed Finial: _____.
 - e. Fasteners: Manufacturer's standard stainless steel bolts, screws, and washers; factory finish fasteners to match fence.
 - f. Accessories: Aluminum castings, extrusions, and cold-formed strips; factory finished to match fence.

- g. Color: As selected by Architect from manufacturer's custom range.

2.4 SPECIALITY HARDWARE

- A. Hinges: Finished to match fence components.
 - 1. Closing: Manual.
 - 2. Mechanism: Spring.
 - 3. Material: Aluminum.
 - 4. Mounting: Center.
 - 5. Brackets: Decorative.
 - 6. Bearings: Plain.
- B. Latches: Finished to match fence components.
 - 1. Mechanism: Gravity.
 - 2. Locking: Mechanical.
 - 3. Material: Steel.
- C. Rollers: Finished to match fence components.
 - 1. Load Rating: 500 pounds (227 kg).
 - 2. Groove: Flat.
 - 3. Material: Steel.

2.5 ACCESSORIES

- A. Keypad Mounting Supports: Where not factory installed, provide mounting supports for keypad installation.
- B. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.
- C. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.
- D. Extension Arms: Cast steel galvanized, to accommodate three strands of barbed wire, single arm, vertical.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Set fence posts in accordance with the manufacturer recommended spacing.
- C. When cutting rails immediately seal the exposed surfaces by:
 - 1. Removing metal shavings from cut area.
 - 2. Apply zinc-rich primer to thoroughly cover cut edge and drilled hole; allow to dry.
 - 3. Apply two coats of custom finish spray paint matching fence color.
 - 4. Failure to seal exposed surfaces in accordance with manufacturer's instructions will negate manufacturer's warranty.

- D. Space gate posts according to the manufacturers' drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected.
 - 1. Base type and quantity of gate hinges on the application, weight, height, and number of gate cycles.
 - 2. Identify the necessary hardware required for the application on the manufacturer's gate drawings.
 - 3. Provide gate hardware by the manufacturer of the gate and install in compliance with manufacturer's recommendations.
- E. Excavate post holes in accordance with Section 31 23 16.
- F. Install operator in accordance with manufacturer's instructions and in accordance with NFPA 70.

3.4 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From Indicated Position: 1 inch.
- C. Minimum Distance from Property Line: 6 inches.

3.5 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Layout: Verify that fence installation markings are accurate to design, paying attention to gate locations, underground utilities, and property lines.
- C. Post Settings: Randomly inspect three locations against design for:
 - 1. Hole diameter.
 - 2. Hole depth.
 - 3. Hole spacing.
- D. Fence Height: Randomly measure fence height at three locations or at areas that appear out of compliance with design.
- E. Gates: Inspect for level, plumb, and alignment.
- F. Workmanship: Verify neat installation free of defects.

3.6 CLEANING

- A. Leave immediate work area neat at end of work day.
- B. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.
- C. Clean fence with mild household detergent and clean water rinse well.
- D. Remove mortar from exposed posts and other fencing material using a 10 percent solution of muriatic acid followed immediately by several rinses with clean water.
- E. Touch up scratched surfaces using materials recommended by manufacturer. Match touched-up paint color to factory-applied finish.

3.7 CLOSEOUT ACTIVITIES

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

3.8 PROTECTION

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

END OF SECTION 32 31 19

SECTION 328400 – LANDSCAPE IRRIGATION PREFORMANCE SPECIFICATION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. It is the intent of this Specification that a finished system is complete in every respect and shall be ready for operation satisfactory to the Landscape Architect and Owner. The design is to be delegated by the contractor and approved by the Landscape Architect.
- B. The work shall include all materials, labor, services, transportation, and equipment necessary to perform the work as indicated in these Specifications, and as necessary to complete the contract.
- C. Section Includes:
 - 1. Pipe and fittings, valves, outlets, backflow preventer, and accessories.
 - 2. Connection to utilities and meter installation.
 - 3. Automatic control system.

1.02 REFERENCES, DEFINITIONS AND APPLICABLE STANDARDS

- A. ASTM D 1785 - Poly Vinyl Chloride (PVC) Plastic Pipe (SDR-PR)
- B. ANSI/ASTM D 2564 - Solvent Cement for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
- C. Reference and comply with applicable plumbing codes, standards, or specifications by building code or governing utility authority for the project location.
- D. Rain Bird Irrigation Installation Details and Specifications.
- E. Irrigation Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.
- F. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50V or for remote control, signaling power-limited circuits.
- G. Notice of Completion: The date at the close of the Maintenance Period when the work has been completed, checked, accepted, and written approval of the work has been given by the Architect.
- H. Date of Acceptance: The date at the end of the warranty periods as specified herein, and written acceptance has been given by the Architect.
- I. Finish Grade: Elevation of finished surface of planting soil within 1/10th of an inch.

1.03 GENERAL DESIGN SYSTEM REQUIRMENTS

- A. Contractor's delegated design for an automatic 2-wire system, electric valve, irrigation system with 100 percent coverage and minimal over spray onto buildings and paved surfaces to meet the following design standards:
 - 1. Compliance with all applicable plumbing codes for the project location.
 - 2. Irrigation water meter and tap to be provided as part of the irrigation system. Meter size and location to be determined by contractor's system design and coordination with owner and general contractor.

3. General Contractor to provide irrigation system sleeving under pavement crossings at the locations and sizes shown in the irrigation shop drawings. Coordinate with General Contractor to provide any additional sleeves that may be necessary.
4. Provide backflow preventer assembly with insulated housing. Provide automatic controller, control wiring, and hardwired connections to power source. Coordinate controller location with owner, general contractor and electrical contractor.
5. Provide wireless rain and heat sensor device to shut off, delay, and adjust watering cycle times.
6. Pipe sizing must provide for a maximum velocity of 5 feet per second and must provide adequate pressure delivery at all heads for proper performance.
7. Provide separate valve zones for turf and planted bed areas.
8. Provide pop-up spray and/or rotor type outlets for turf areas.
9. Space spray and/or rotor type outlets to provide near 100% overlapped coverage between each outlet.
10. Provide drip irrigation for planted bed areas.
11. Provide drip pop up indicators at all drip areas.
12. Provide additional drip emitters for trees in drip zone areas.
13. Coordinate the locations of controller and backflow preventers to minimize visibility and screen with landscape materials where possible.
14. Piping to be located along back of curbs, pavement edges, and bed edges.
15. Spray from perimeter of areas where feasible.
16. Provide 100% coverage of all newly planted landscape areas on site and in adjacent street rights-of-way and/or other areas as indicated in the Landscape Plan.
17. Provide manual drain valves and sumps, or piped connections to drainage system in sufficient locations to drain the entire system for winterizing.
18. Provide valve boxes and covers at all locations described. Align all valve boxes parallel or perpendicular to adjacent hardscape where applicable.
19. Minimize the number of outlets, trenching, and pipe installation where possible.

1.04 PRE-CONSTRUCTION SUBMITTALS

- A. Contractor to provide a delegated design for a fully automated 2- wire irrigation system to be review and approved by the Landscape Architect through shop drawings.
- B. Product Data:
 1. Prior to ordering of any materials, and for each type of product indicated provide submittals for acceptance by the

Landscape Architect. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

2. The submittals shall include the following information:

- a. A title sheet with the job name, the Contractor's name, address and telephone number, submittal date and submittal number.
- b. Shop Drawings with the following clearly indicated: Irrigation layout plan showing the sleeving locations, mainline routing, lateral line routing, controller location, meter location, backflow location and head or drip line locations.
- c. An index sheet showing the item number (i.e. 1, 2, 3, etc.); an item description (i.e. sprinkler head); the manufacturer's name (i.e. Rain Bird); the item model number (i.e. 44DLRC); and the page(s) in the submittal set that contain the catalog cuts.
- d. The catalog cuts shall clearly indicate the manufacturer's name and the item model number. The item model number, all specified options and specified sizes shall be circled or highlighted on the catalog cuts.
- e. Submittals for equipment shall contain the manufacturer, Class or Schedule, ASTM numbers and/or other certifications as indicated in these specifications.

3. Submittal format requirements:

- a. Submittals shall be provided as one complete package for the project. Multiple or partial submittal packages will not be reviewed.
- b. Submittal package shall be submitted as a single PDF file.

1.05 POST CONSTRUCTION SUBMITTALS

A. Record Drawings

1. Record accurately on one set of drawings all changes in the work constituting departures from the original approved Shop Drawings and the actual final installed locations of all required components as shown below.
2. Record Drawings shall be prepared to the satisfaction of the Architect. Prior to final inspection of work, submit Record Drawings to the Architect.
3. Show locations and depths of the following items:
 - a. Point of connection (including water POC, basket strainer, pressure regulator, master control valve, flow sensors, etc.)
 - b. Routing of sprinkler pressure main lines (dimensions shown at a maximum of 100 feet along routing.)
 - c. Isolation valves.
 - d. Mainline air release valves.
 - e. Automatic remote-control valves (indicate station number and size.)
 - f. Quick coupling valves.
 - g. Routing of control wires where separate from irrigation mainline.
 - h. Irrigation controllers
 - i. Related equipment (as directed)

B. Controller Charts:

1. Provide one controller chart for each automatic controller. Chart shall show the area covered by the controller. The areas covered by the individual control valves shall be indicated using colored highlighter pens. A minimum of six individual colors shall be used for the controller chart unless less than six control valves are indicated.
2. When completed and approved, the chart shall be hermetically sealed between two pieces of plastic, each piece being a minimum 20 mils in thickness. The contractor is to provide a minimum of three (3) copies to the owner.

1.06 FIELD QUALITY CONTROL

- A. Provide at least one English speaking person who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of materials being installed and the manufacturer's recommended methods of installation and who shall direct all work performed under this section.
- B. Manufacturer's directions and detailed drawings shall be followed in all cases where the manufacturer of articles used in this contract furnish directions covering points not shown in the Specifications.
- C. All local, municipal, and state laws, rules and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications, and their provisions shall be carried out. Anything contained in these Specifications shall not be construed to conflict with any of the above rules and regulations of the same. However, when these Specifications call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, the provisions of these Specifications shall take precedence.
- D. Materials supplied for this project shall be new and free from any defects. Defective materials shall be replaced immediately at no additional cost.
- E. Secure the required licenses and permits including payments of charges and fees, give required notices to public authorities, verify permits secured or arrangements made by others affecting the work of this section.
- F. Acquire certificate of compliance from local authority indicating approval of backflow preventer installation.

1.07 FIELD MEASUREMENTS

- A. Verify that field conditions are as shown in the drawings. Revise design and record drawing as required.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- B. Exercise care in handling, loading, unloading, and storing plastic pipe and fittings under cover until ready to install. Transport plastic pipe only on a vehicle with a bed long enough to allow the pipe to lay flat to avoid undue bending and concentrated external load.
- C. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.
- D. Use all means necessary to protect irrigation system materials before, during, and after installation and to protect the installation work and materials of all other trades. In the event of damage, immediately make all repairs and replacements necessary to the acceptance of the Landscape Architect and at no additional cost.

1.09 PROJECT CONDITIONS

- A. Verify and determine the locations, size and detail of points of connection provided as the source of water and electrical supply to the irrigation system.
- B. Irrigation design shall be based on the available water pressure. Verify the dynamic water required is available on the project prior to the start of construction. Should a lack of pressure exist to achieve the flow necessary to operate the system, notify the Landscape Architect prior to beginning construction.
- C. Prior to cutting into the soil, locate all cables, conduits, sewer septic tanks, and other utilities that are commonly encountered underground, and take proper precautions not to damage or disturb such improvements. If a conflict exists between such obstacles and the proposed work, promptly notify the Landscape Architect who will arrange for relocations. Proceed in the same manner if a rock layer or any other such conditions are encountered. Call in utility locates prior to all trenching or excavation.
- D. Protect all existing utilities and features to remain on and adjacent to the project site during construction. Repair, at Contractor's

own cost; all damage resulting from Contractor's operations or negligence.

- E. Coordinate installation of required sleeving per approved Shop Drawings
- F. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied, unless permitted under the following conditions and then only after arranging to provide temporary water service according to the requirements indicated:
 - 1. Notify Water Utility provider prior to Interruption.
 - 2. Notify Architect no fewer than two working days (48 hours) in advance of proposed interruption of water service.
 - 3. Do not proceed with interruption of water service without the Architect's written permission.

1.10 GUARANTEE

- A. The entire irrigation system, including all work done under this contract, shall be unconditionally guaranteed against all defects and fault of material and workmanship, including settling of backfilled areas below grade, for a period of one (1) year following the approved final acceptance.
- B. Should any problem with the irrigation system be discovered within the guarantee period, it shall be corrected by the Contractor at no additional expense to the Owner within ten (10) calendar days of receipt of written notice from the Landscape Architect. When the nature of the repairs as determined by the Landscape Architect constitutes an emergency (i.e. broken mainline) the Landscape Architect may proceed to make repairs at the Contractor's expense. Damages to existing improvement resulting either from faulty materials or workmanship shall be repaired to the satisfaction of the Landscape Architect by the Contractor, all at no additional cost.
- C. Manufacturer's warranties shall not relieve the Contractor of his liability under the guarantee. Such warranties shall only supplement the guarantee.

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. A. Rain Bird Corporation, Turf Division: For all irrigation system equipment and accessories.
- B. NDS: For valve boxes.
- C. Wilkins/Zurn: For backflow preventers

2.2 MATERIALS

- A. Pipe:
 - 1. PVC in accordance with ASTM D 1785: PVC Schedule 40 pipe for all sleeving, main lines, lateral lines, and fittings throughout system. Solvent-weld sockets.
 - 2. Rigid copper pipe required from tap at public main through backflow preventer.
- B. Fittings: Type and style of connection to match pipe.
- C. Solvent Cement: ANSI/ASTM D 2564 for PVC pipe and fittings.
- D. Tracer Wire: 14 AWG solid copper wire with insulating cover, to be tagged as "Tracer wire" with metal tags. Color of insulating cover must be different from other wiring.

2.3 MATERIALS

A. Turf Outlets:

1. Spray Outlets: Pop-up spray bodies, 6 inch minimum to 12 inch riser heights as needed for adequate performance, with installed check valves and pressure regulating devices.
2. Stream Rotor Outlets: Pop-up stream rotor bodies, 6 inch and/or 12 inch riser heights as needed for adequate performance, with installed check valves and internal pressure regulating devices. Rotors without internal pressure regulation may be used if combined with a pressure regulating PVC pipe swing joint.

B. Drip System Outlets:

1. Drip Line: Pressure compensating surface type installation drip line with flexible tubing, 12 inch emitter spacing, and internal emitter check valves. Anchor line with galvanized wire anchors at 24"-30" spacing. Lines and connector fittings must be capable of operating at 50 PSI without supplementary clamps.
2. Drip Emitters: Pressure Compensating drip emitters for additional water to tree placements within drip zones; one drip emitter for each ornamental size tree and two drip emitters for each medium or large size tree. Provide diffuser caps for each emitter.

2.4 BACKFLOW PREVENTERS

- A. Control Valves: Electric solenoid operating valves with glass filled nylon body construction. Size valves for minimum pressure loss for designed flow rate. Provide and install pressure regulating devices for each valve placement.
- B. Backflow Preventer: Wilkins/Zurn: 975XL or 975XLSEU backflow preventer sized for maximum flow in system with a maximum pressure loss limited to 10% of available residual pressure.
- C. Backflow Preventer Housing: DekoRRa model 301/302, Class II, turf brown granite color, anchored to 4" minimum concrete base per manufacturer's details and specifications. Provide minimum size to cover with insulation bag.

2.5 CONTROLS

- A. Controller: Automatic controller for electric valve operation sized for required number of stations, with grounding per manufacturer specifications and hardwired connections to power source.
- B. Controller Housing:
1. Indoor Installations: Wall mount plastic housing with lockable access door. Indoor installations must be able to accommodate wiring or wireless system remote operation of rain and heat sensing device. Coordinate with electrician for power source
 2. Outdoor Installations:
 - a. Wall Mount: Stainless steel housing with lockable access door.
 - b. Ground Mount: Stainless steel housing and pedestal with lockable access door.
- C. Accessories: Include required fittings, galvanized metal electrical conduit, and accessories for installation.
- D. Control Wiring: Gauge of wire to be sized by contractor for adequate operation of valves. Use waterproof connectors for all connections. Use different color wire jackets for valve power wires and white jacket for common wire.
- E. System Grounding: Provide grounding at controller and throughout control wiring and valve layout to meet manufacturer's standards with grounding devices as recommended by manufacturer.
- F. Rain and Heat Sensor Device: Wireless automatic, adjustable, shutoff device to disable/delay operations during or after recent

rainfall and adjust watering cycle times for local heat and rainfall conditions. Provide and install connection equipment necessary for operation at controller.

2.6 OTHER EQUIPMENT

- A. Swing Joints: Provide PVC pipe swing joints for all full circle rotor outlet placements.
- B. Pressure Regulating Swing Joints: Provide pressure regulating PVC pipe swing joints for all rotor outlet placements without internal pressure regulation.
- C. Valve Boxes and Covers: Valve boxes and covers required for all control valves, drip filters, drain valves, surge protector devices, wiring changes of direction, and wiring junctions.
- D. Drip Filters: Replaceable and/or cleanable sized to match zone flows, installed with valve in valve box.
- E. Drain Valves: Manual, PVC valves on tees for low points in system.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.
- B. Verify location of existing utilities. Repair utilities damaged as a result of this work at no increase in Contract Sum.
- C. Verify that required utilities are available in proper location and ready for use.
- D. Verify available water pressure at meter or backflow preventer locations.
- E. Verify sleeve locations.
- F. Beginning of installation means installer accepts existing conditions.

3.2 PREPARATION

- A. Layout and stake locations of system components.
- B. Review layout requirements with other affected work. Coordinate locations of sleeves under paving to accommodate system. Notify Architect/Engineer for approval of field changes to system design.
- C. Coordinate location of controller, rain and heat sensor device, and connections to power source with Owner, General Contractor, and Electrical Contractor.

3.3 TRENCHING

- A. Minimum Trench Depth: Trench depth must provide a minimum of 18 inches of cover over all main lines and wiring and 12 inches of cover over all lateral lines.
- B. Trench to accommodate grade changes and slope to manual drain valves at low points in system.
- C. Maintain trenches free of rocks, obstructions, or other debris that may damage pipe or wiring.

- D. Repair or replace existing improvements damaged by work performed under this contract with equivalent materials or products.

3.4 INSTALLATION

- A. Install irrigation sleeving under all pavement crossings and buried at a minimum depth of 18 inches below finish grade. All sleeving trenches must match finish grade and be compacted to minimum subgrade requirements for paving.
- B. Install pipe, backflow preventer, valves, valve boxes, wiring, grounding, drains, controls, and outlets in accordance with all applicable plumbing codes, manufacturer's details, instructions, and minimum standards.
- C. Trenches for irrigation main and lateral lines must match finish grade and be compacted to the degree that no settlement will occur.
- D. Install cast concrete thrust blocking at all piping bends for 3 inch or larger pipe sizes.
- E. Install zone valves with pressure regulating devices in valve boxes per manufacturer specifications and details. Provide metal tag with zone number for each valve.
- F. After piping is installed but before sprinkler heads are installed and trenches backfilled, open valves and flush system with full head of water.
- G. Install spray and rotor outlets with fittings, flex pipe, swing joints, etc. Use threaded connections to lateral lines. Install in accordance with manufacturer's details, instructions and minimum standards.
- H. Install drip lines, emitters, filters, fittings, etc. in accordance with manufacturer's details, instructions and minimum standards. Anchor line with galvanized wire anchors at 3 feet on center, minimum spacing.
- I. Install manual drain valves at system piping low points and pipe connections from valves to site drainage system, or, provide 12" diameter by 24" deep, gravel filled drain sumps where piped connections are not feasible.
- J. Connect to water and electrical services.
- K. Set outlets and box covers at finish grade elevations.
- L. Install control wiring in trenches along with main lines to valves and provide 30-inch expansion coil at each valve and change of direction. Also provide 30-inch expansion coils at 100-foot intervals between valves.
- M. Tracer Wire: Install tracer wire from gate valve at backflow preventer along all main lines to each zone valve. Terminate at valve boxes with 24" wire coil and metal tags labeled as "Tracer Wire."
- N. Install automatic controller. Provide hardwired connection to power source, enclose wiring to system and power source in rigid metal conduit where exposed. Paint exposed conduit to match building exterior.
- O. Install rain and heat sensor device and wireless connection device to controller. Verify proper operation of device.
- P. Program remote irrigation controller and install connection equipment necessary for operation at controller. Verify proper operation of remote.
- Q. Repair or replace any other work or improvements damaged as a result of work related to system installation at no increase to the Contract Sum.

3.5 FIELD QUALITY CONTROL

- A. Prior to backfilling and installation of outlets, cap or plug pipes and test system for leakage. Maintain maximum available pressure for one hour. Piping is acceptable if no leakage or loss of pressure occurs during test period.

3.6 ADJUSTING

- A. Adjust control system to achieve time cycles required for adequate watering at time of installation.
- B. Adjust heads and/or nozzles to achieve proper coverage and performance. Make nozzle or head changes as necessary for proper coverage.
- C. Adjust zone valves for proper operating pressures at valve zones.

3.7 EXTRA MATERIALS

- A. Furnish to Owner the following extra components:
 - 1. Two sprinkler heads of each type and size.
 - 2. Two nozzle inserts for each type and size.
 - 3. Two drip emitters of each type and size
 - 4. Two drip line basket filters of each type and size.
 - 5. Two keys each for valve boxes and controller (if locked boxes are used).
 - 6. Two of any required special tools for adjustment or replacement of each type of outlet, nozzle, valve, and other system equipment.

3.8 CLOSEOUT

- A. Provide system demonstration to Owner and Architect/Engineer for review and final acceptance of work. Coordinate demonstration of procedures for winterizing (draining system lines, backflow preventer, etc.) and spring start-up with Owner. Review system operation and components during service visit.
- B. Instruct Owner or representative in operation and maintenance of system, including adjusting of sprinkler heads. Use operation and maintenance material as basis for demonstration.
- C. Deliver record drawing of system, required operation and maintenance information, extra materials and backflow preventer certificate to Owner at the instruction meeting.

3.9 WARRANTY

- A. Provide one-year materials and workmanship warranty on all system components and installation beginning on date of acceptance of the work.
- B. Replace failed components immediately upon notification by Owner or Architect/Engineer.

END OF SECTION 328400

SECTION 319113 – SOIL PREPARATION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section includes materials, labor, apparatus, tools, equipment, temporary construction, transportation, and services necessary for and incidental to performing the proper completion of Work, as required to make a complete and thorough preparation of the planting soil, including soil amendment products, imported topsoil, as required, to make up deficiencies in quantity of soil available on site, as shown in the Contract Drawings, and as specified herein this Section.
- B. Work under this Section consists of, but is not necessarily limited to, furnishing and installing the following:
1. Agronomic Soil Fertility Testing and Soil Percolation Testing.
 2. Topsoil.
 3. Pre-Plant Weed Control.
 4. Soil Conditioners, Amendments and Fertilizers (Organic & Chemical).
- C. Related Work
1. Section 31 2000: Earthwork
 2. Section 32 9300: Exterior Plants
 3. Section 32 8400: Irrigation Systems
 4. Section 32 9200: Turf Grasses

1.02 DEFINITIONS AND APPLICABLE STANDARDS

- A. References:
1. USDA – United States Department of Agriculture.
 2. ASTM – American Society for Testing & Materials.
- B. Definitions:
1. Topsoil - Shall be friable soil, providing sufficient structure in order to give good tilth and aeration to the soil. Topsoil shall be free of roots, clods, stones larger than one-inch (1") in the greatest dimension, pockets of coarse sand, noxious weeds, sticks, lumber, brush and other litter. It shall not be infested with nematodes or other undesirable disease-causing organisms such as insects and plant pathogens.
 2. Gradation Limits - Soil shall be a sandy loam, loam, clay loam or clay. The definition of soil texture shall be per the USDA classification scheme. Gravel over ¼-inch in diameter shall be less than 20% by weight.
 3. Permeability Rate - Hydraulic conductivity rate shall be not less than one-inch (1") per hour, nor more than twenty-inches (20") per hour, when tested in accordance with the USDA Handbook Number 60, Method 34b, or other approved Methods.
 4. Fertility - The range of the essential elemental concentration in soil shall be as follows: (cont. next page)

Ammonium Bicarbonate/ DTPA Extraction (PPM)		
Element	Concentration of elements for Soil Selection, measured as mg/kilogram dry weight basis	Concentration of Elements for Final Acceptance (amended and conditioned soil) measured as mg/kilogram dry weight basis
Phosphorus	2 - 40	10 – 40
Potassium	40 - 220	100 – 220
Iron	2 - 35	24 – 35
Manganese	0.3 - 6	0.6 – 6
Zinc	0.6 - 8	1 – 8
Copper	0.1 - 5	0.3 – 5
Boron	0.2 - 1	0.2 – 1
Magnesium	50 - 150	50 – 150

Sodium	0 - 100	0 – 100
Sulfur	25 - 500	25 – 500
Molybdenum	0.1 - 2	0.1 - 2

5. Acidity - The soil pH range measured in the saturation extract (Method 21a, USDA Handbook Number 60) shall be 6.0 – 7.9.
6. Salinity - The salinity range measured in the saturation extract (Method 3a, USDA Hand Number 60) shall be 0.5 – 2.0 dS/m. If calcium and if sulfate ions both exceed 20 milli-equivalents per liter in the saturation extract, the maximum salinity shall be 4.0 dS/m.
7. Chloride - The maximum concentration of soluble chloride in the saturation extract (Medoth3a, USDA Handbook Number 60) shall be 150 mg/1 (parts per million).
8. Boron - The maximum concentration of soluble boron in the saturation extract (Method 3a, USDA Handbook Number 60) shall be 1 mg/1 (parts per million).
9. Sodium Adsorption Ratio (SAR) - The maximum SAR shall be 3 measured per Method 20b, USDA Handbook Number 60.
10. Aluminum – Available aluminum measured with the Ammonium Bicarbonate/DTPA Extraction shall be less than 3.0 parts per million.
11. Soil Organic Matter Content - Sufficient soil organic matter shall be present to impart good physical soil properties but not be excessive to cause toxicity or cause excessive reduction in the volume of soil due to decomposition of organic matter. The desirable range is 3% to 5%. The carbon:nitrogen ratio should be about 10. A high carbon:nitrogen ratio can indicate the presence of hydrocarbons or non-humified organic matter.
12. Calcium Carbonate Content - Free calcium carbonate (limestone) shall not be present in acid-loving plants.
13. Heavy Metals - The maximum permissible elemental concentration in the soil shall not exceed the following concentrations: (cont. on next page)

Ammonium Bicarbonate/ DTPA Extraction (PPM)	
Element	(mg/kilogram) dry weight basis
Arsenic	1.0
Cadmium	1.0
Chromium	10.0
Cobalt	2.0
Lead	30.0
Mercury	1.0
Nickel	5.0
Selenium	3.0
Silver	0.5
Vanadium	3.0

- a. If the soil pH is between 6 and 7, the maximum permissible elemental concentration shall be reduced 50% to the above values. If the soil pH is less than 6.0, the maximum permissible elemental concentration shall be reduced 75% of the above values. No more than three (3) metals shall be present at 50% or more of the above values.
14. Phytotoxic constituent, herbicides, hydrocarbons, etc. – Germination and growth of plants shall not be restricted more than 10% compared to the reference soil. Total petroleum hydrocarbons shall not exceed 50 mg/kg dry soil measured per the modified EPA Method No. 8015. Total aromatic volatile organic hydrocarbons (benzene, toluene, xylene and ethylbenzene) shall not exceed 0.5 mg/kg dry soil measured per EPA Method No. 8020.
15. Sub Grade - Soil level resulting from the rough grading work under another Section. Cultivation of sub grade areas prior to placement of Topsoil is included in this Section.
16. Stockpiled Topsoil - Soil stockpiled for spreading over prepared sub-grade.
17. Stockpiled Native Topsoil - Topsoil stripped from the site prior to rough grading Work (under another Section), to be spread and amended as Work under this Section.
18. Imported Topsoil - Off-site Topsoil, imported and stockpiled under this Section, to be spread and amended as Work under this Section.

C. Measurements:

1. PPM: Measurement, in parts per million.

1.03 QUALITY ASSURANCE

A. Installer Qualifications for requirements indicated herein this Section:

1. Licensed Landscape Contractor, in the State of Arkansas.

- a. Engage an experienced, licensed Contractor who has completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful landscape establishment.
- b. Installer's Field Supervision: Contractor shall maintain an experienced, full-time landscape supervisor/superintendent at the Project Site during times that landscaping operations identified herein the Contract are in progress.

B. Manufacturer's Directions: Follow Manufacturer's directions and drawings in cases where the Manufacturers of articles used in this Section furnish directions covering points not shown in the Contract Drawings or Contract Specifications.

C. Permits, Fees, Bonds, Testing, and Inspections: Contractor shall arrange and pay for permits, fees, bonds, testing, and inspections necessary to perform and complete his portion of the Work.

D. Approved Testing Laboratory and Procedures for Agronomic Soil Fertility Analyses:

1. Agronomic Soil Fertility Analyses shall be conducted by a reputable, certified, agronomic soils laboratory. Laboratory shall be a member of the Council on Soil Testing and Plant Analysis. The same laboratory shall be used throughout the duration of the Contract:
2. Contractor shall verify and confirm the selected Testing Laboratory and specific location(s) of soil sample(s) with the Landscape Architect prior to commencing soil sampling operations.
3. For each Soil type, submit the physical Soil Samples directly to the selected Laboratory for analysis, per the procedures outlined per Part III herein this Section.
 - a. In addition to the physical Soil Samples, Contractor shall also provide the Laboratory with a copy of the Soil Amendment and Fertilizer products indicated herein this Section.
4. Along with the testing data results, the Agronomic Soil Fertility Analysis shall also include written recommendations authored by the Laboratory conducting the Analyses for amending, treating, and/or correcting the sampled soils. Laboratory shall utilize the organic-based Soil Amendments and Fertilizers described herein this Section to the greatest extent possible to produce satisfactory planting soil(s) suitable for sustaining healthy viable plant growth.
 - a. The Analyses shall also include Maintenance and Post-Maintenance fertilization programs for planted areas within the Contract.
5. Agronomic Soil Fertility Analyses shall be performed on each Soil Type samples, and include testing results for the following:

pH;
Electro-conductivity (salinity) measurement – saturated extract.
Measurement of sodicity (Sodium Absorption Ratio);
Estimate of soil texture and soil organic matter;
Presence of lime;
Nutrients/Toxic Elements measurement of DPTA extract
Saturation extracts for nitrate, sulfate, sodium, calcium, magnesium, potassium, soluble phosphate, and boron;
Parasitic nematodes;
Herbicide contamination;
(For Lightweight Soil Mixes): Test for physical and chemical composition, and saturated weight per cu.ft.

6. Planting operations shall not commence until the results of the Agronomic Soil Fertility Analysis and Recommendations are reviewed accordingly by the Landscape Architect.

7. The quantity or type of amendments may be modified by the Landscape Architect within fourteen (14) days of receipt of the results. The Agronomic Soil Fertility Analysis and Recommendations shall take precedence over the amendment and fertilizer application rates specified herein or on the Contract Documents.
8. The Agronomic Soil Fertility Report/Recommendation shall take precedence over the amendment and fertilizer application rates specified herein or on the Contract Documents.

1.04 SUBMITTALS

A. General:

1. Collect information into a single Submittal for each element of construction and type of product or equipment identified under this Section for review.
2. Submittal Format: As applicable, furnish Submittal as a single electronic digital PDF (Portable Document Format) file.

B. Digital Submittal Information:

1. Product/Material Data: Submit available product/material literature supplied by manufacturer's, indicating that their products comply with specified requirements. Provide manufacturing source (name, address, and telephone number), and distributor source (name, address, and telephone number) for each type of product/material.
 - a. Planting Soil (Imported/Amended Topsoil).
 - b. Soil Amendments (for each type used, for Sand, Perlite, Peat Humus, Gypsum, Soil Sulfur, Iron, etc).
 - c. Bulk Composted Organic Soil Amendment Material.
 - d. Granular Soil Conditioning Material.
 - e. Mycorrhizal Inoculum.
 - f. Fertilizers (for each type used).
2. Agronomic Soil Fertility Analysis and Recommendations: Submit a minimum of fourteen (14) days prior to amending of the soil and ordering soil amendments. The locations of where each of the soil test samples were derived from the Project Site shall be keyed to the site plan and shall be included with the results.
3. Qualification Data: Submit names for firms and persons specified in the "Quality Assurance and Control" Article to demonstrate their capabilities and experience on similar installations.

C. Material Samples: Submit four (4) sets of physical Material Samples for review of kind, color, pattern, size, 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. Include the full range of exposed color and texture expected in the completed work. Provide Material Samples bound and individually wrapped in re-sealable labeled 1-gallon plastic bags (as applicable):

1. Provide Material Sample sets for each item submitted under Product/Material Data.

D. Submittals under this Article will be rejected without the benefit of review by the Landscape Architect if they are difficult to read due to insufficient scale, poor image quality, or poor drafting quality; or if the required information is missing or not presented in the format as requested.

E. No Work shall proceed under this Section until Submittal requirements indicated herein have been reviewed accordingly by the Landscape Architect.

1.05 DELIVERY, STORAGE, AND HANDLING

A. General: Deliver and install materials so as to not delay Work and install only after preparations for installation have been completed.

1. Packaged Materials: Deliver packaged materials in original, unopened packages or containers, with manufacturer's labels intact and legible, showing weight, analysis, and name of manufacturer. Store and secure properly to prevent theft or damage.
 - a. Store packaged materials off ground and under cover, away from damp surfaces and inclement weather.
 - b. Protect during storage and construction against soilage or contamination from earth and other materials.
2. Bulk Materials:
 - a. Deliver and store bulk materials so as not to impede Work of others.

- b. Do not dump or store bulk materials near structures, utilities, walkways, and pavements, or on existing turf areas, or plants.
- c. Protect during storage and construction against soilage or contamination from earth and other materials. Provide adequate separation between bulk materials so as not to cross-contaminate bulk materials.
- d. Store under cover, away from inclement weather.
- e. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water run-off, and airborne dust reaching adjacent properties, water conveyance systems, structures, or walkways.
- f. Accompany each delivery of bulk materials (fertilizers, amendments, topsoil, etc.) with appropriate certificates. Furnish original certificates to Landscape Architect upon request.

1.06 COORDINATION, SCHEDULING, AND OBSERVATIONS

- A. Notify the Contractors performing Work related to installation of Work under this Section in ample time to allow sufficient time for them to perform their portion of Work and that progress of Work is not delayed. Verify conditions at the Project Site for Work that affects installation under this Section. Coordinate items of other trades to be furnished and set in place.
- B. Utilities: Determine location of above grade and underground utilities and perform Work in a manner which will avoid damage to utilities. Hand excavate, as required. Maintain grade stakes until removal is mutually agreed upon by parties concerned.
- C. Excavation: When conditions detrimental to adequate Soil Preparation operations are encountered, such as rubble fill, adverse drainage conditions, or obstructions, cease operations and notify Landscape Architect for further direction.
- D. Installation: Perform Soil Preparation operations only when weather and soil conditions are suitable in accordance with locally accepted practices.
- E. Construction Site Observations: Periodic site observations shall be made by the Landscape Architect during the installation of Work under this Section for compliance with requirements for type, size, and quality. Landscape Architect retains right to observe Work for defects and to reject unsatisfactory or defective material at any time during progress of Work. Contractor shall remove rejected materials immediately from Project site, all associated cost are to be paid by the contractor.

1.07 SITE CONDITIONS

- A. Project Site shall be free of weeds, native grasses, evasive grasses, (Bermuda Grass, Johnson Grass, Nut Grass, etc.) prior to Topsoil distribution or soil amendment placement.
- B. Excessive rock, dead or declining vegetation, trash, debris, or other items that has accumulated throughout the duration of the Project shall be removed from the Project Site by the Contractor, and as directed by the Landscape Architect.
- C. Grading and soil preparation Work shall be performed only during the period when beneficial and optimum horticultural results may be obtained. If the moisture content of the soil should reach such a level that working it would destroy soil structure or cause compaction, spreading and grading operations shall be suspended until, in the opinion of the Landscape Architect, the moisture content is increased or reduced to acceptable levels and the desired results are likely to be obtained.
 - 1. Soil moisture level prior to planting shall be no less than 75% of field capacity. The determination of adequate soil moisture for planting shall be in the sole judgment of the Landscape Architect.
 - 2. If the soil moisture level is found to be insufficient for planting, planting pits shall be filled with water and allowed to drain before commencing planting operations.
- D. Planting areas which become compacted in excess of 85% relative compaction due to construction activities shall be tilled and thoroughly cross-ripped to a minimum depth of twelve-inches (12") to alleviate the condition, taking care to avoid all existing subsurface utilities, drainage, etc.

PART 2 - PRODUCTS

2.01 PLANTING SOIL (TOPSOIL)

- A. Topsoil: Meet ASTM D5268, pH range of 5.5 to 7, 4 percent organic material minimum.

SOIL PREPARATION

1. Topsoil Source: Reuse native surface soil stockpiled on the site. Verify suitability of native surface soil stockpiled on site to produce Topsoil meeting requirements; amend, as necessary. Supplement native surface soil stockpiled on site with imported Topsoil when quantities are insufficient.
 - a. Composition: Fertile, friable, well-drained soil, of uniform quality, free of stones over one-inch (1") diameter or larger in any dimension sticks, oils, chemicals, plaster, concrete, roots, plants, sod, and other deleterious or extraneous materials harmful to plant growth.
 - b. Obtain an Agronomic Soil Fertility Report/Recommendation of the stockpiled Topsoil from the approved Testing Laboratory indicated herein this Section.
 - c. Test Results: Request Testing Agency to send one (1) copy of test results direct to the Landscape Architect and one (1) copy to the Owner. Amend as required.
2. Topsoil Source: Provide Imported Topsoil obtained from off-site sources, from naturally well-drained sites; do not obtain from bogs or marshes.
 - a. Quantity: Provide Imported Topsoil as soon as an insufficient quantity of native stockpiled surface soil is verified. Quantity of Imported Topsoil to complete the Work shall be calculated by Contractor.
 - b. Stockpiling: Stockpile on site as directed by Owner.
 - c. Composition: To match in quality, accepted native stockpiled Topsoil.
 - d. Analysis: Obtain an Agronomic Soil Fertility Report/Recommendation of the Imported Topsoil from the approved Testing Laboratory indicated herein this Section.
 - e. Review: Landscape Architect reserves the right to take samples of the Imported Topsoil delivered to the site for conformance to the Contract Specifications.
 - f. Rejected Imported Topsoil: Immediately remove rejected Imported Topsoil off site, at Contractor's expense.

2.02 SOIL MIXES/BLENDS (BACKFILL/PLANTING MIX)

- A. Soil Conditioner Blend, for amending on-site native soil planting surfaces, stockpiled, plant back fill or imported topsoil: Furnish a thoroughly blended composition of Bulk Composted Organic Soil Amendment Material and Granular Soil Conditioning Material & Fertilizer. Any substitution for the "Soil Conditioner Blend" listed herein must be requested by the Contractor and approved, in writing, by the Landscape Architect at least thirty (30) days prior to installation.

1. Bulk Composted Organic Soil Amendment Material:
 - a. Material Composition: Bulk Composted Organic Soil Amendment Material shall be thoroughly cured for a minimum of 100 days, and shall be free from any trash (glass, metal, plastic, etc.) deleterious materials, bio-solids, and/or toxic chemicals. The Material shall be non-hazardous, and conform to US Environmental Protection Agency 40 CFR503 criteria for "Class A" products. It shall also exceed standards and specifications for unrestricted application as a landscaping and agricultural soil amendment.
 - b. Humus material shall have an acid-soluble ash content of no less than 6% and no more than 20%. The organic matter content shall be at least 50% on a dry weight basis.
 - c. Types of acceptable products are composts, manures, mushroom composts, straw, alfalfa, peat mosses etc. low in salts, low in heavy metals, free from weed seeds, free of pathogens and other deleterious materials.
 - d. Composted wood products are conditionally acceptable [stable humus must be present]. Wood based products are not acceptable which are based on red wood or cedar.
 - e. Sludge-based materials are not acceptable.
- 1) Gradation/Screen Analysis: A minimum of 90% of the material by weight shall pass a 1/2" screen. Material passing the screen shall meet the following criteria:

Percent Passing	Sieve Designation
80 – 100%	6.35 mm (1/4")
50 – 80%	2.38 mm (No.8)
0 – 40%	500 micron (No.35)

- 2) Maturity: Physical characteristics suggestive of maturity include shall include:
 - a) Color: Dark brown to black.
 - b) Odor: Aerobic, without malodorous presence of decomposition products.
 - c) Particle characterization: Identifiable wood pieces are acceptable, but the balance of Material should be soil-like without recognizable grass or leaves.

- d) Analytical Properties: Contractor shall submit proof of the Bulk Composted Organic Soil Amendment Material by providing a sample as identified herein this Section, and a lab analysis that has been performed within 30 days of the installation of the planting. Soil mix shall have (at a minimum) the following properties:

Material	Minimum Targeted Property/Range
Total Nitrogen (N%)	.50-1.0%
Phosphorus (as P ₂ O ₅)	2.0%
Potassium (as K ₂ O)	0.2%
pH (units)	6.0 to 7.5, as determined in saturated paste.
Organic Content	Minimum 50% based on dry weight and determined by ash method. Minimum 205 lbs. organic matter per cubic yard of compost.
ECe (millimho/cm)	<5.0; based on pre-leaching with equal volume of water.
Carbon-to-Nitrogen Ratio	<25-to-1, nitrogen stabilized.
Bulk Density	1,000 to 1,100 pounds/cubic yard.
Sodium Absorption Ratio (SAR)	Under 20.0
Total Iron	1.5% - 3.0%
Moisture Content	35%-60%
Acid-soluble Ash content	No less than 6% and no greater than 20%.
Salt Content	<10millimho/cm @ 25d C. on a saturated paste extract.
Boron Content	<1.0 parts per million on a saturated paste extract.
Silicon-Content (acid-insoluble ash)	<50%
Calcium Carbonate	No presence on alkaline soils.
Maximum Total Permissible Pollutant Concentrations Parts per million (mg/kg dry-weight basis)	<ul style="list-style-type: none"> • Arsenic: 1.0 • Cadmium: 1.0 • Chromium: 10.0 • Cobalt: 2.0 • Copper: 1.0 • Lead: 30.0 • Mercury: 1.0 • Molybdenum: 2.0 • Nickel: 5.0 • Selenium: 1.0 • Silver: 0.5 • Vanadium: 3.0 • Zinc: 2.0

- e) Application Rate: As indicated herein this Section under "Planting Soil Amendments Schedule".
f) Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

- 3) Provide submittal and sample to be approved by the Landscape Architect.

2. Granular Soil Conditioning Material & Fertilizer:

- a. Material Composition and Analytical Properties: Granular Soil Conditioning Material & Fertilizer shall be a singular manufacturer-blended combination of soil conditioning material and fertilizer. It shall be granular in form, long-lasting, free flowing, and suitable for application with approved equipment. It shall not contain any sewage sludge or manure-based products, and shall contain the following guaranteed minimum available analysis range:

Element/Material	Targeted Property Range
Nitrogen (N)	5.0% to 6.0%
Phosphoric Acid (as P ₂ O ₅)	2.0% to 3.0%
Potash (as K ₂ O)	1.0% to 4.0%
Humic Acids	15.0 % to 20.0%

Calcium	7.0%
Sulfur	0.0% to 5.0%

- b. Commercial-Grade Products, Manufacturers and Associated Rates of Application: Subject to compliance with requirements.

1) Provide submittal and sample to be approved by the Landscape Architect.

- B. Washed Plaster Sand: Clean, washed, natural or manufactured sand, sharp, fine-textured, free of toxic materials. Sieve tested in accordance with ASTM C136, with 100% passing through a #4 screen, 0% passing through a #200 screen.

1. Chemical Properties: (by DPTA Saturation Extract Method):

- Soluble Salts/Salinity: Maximum conductivity of 3.0 millimhos/cm at 25 degrees C.
- Boron: Maximum concentration of 1.0 PPM.
- Sodium Absorption Ratio (SAR): Maximum 6.0.
- pH: 7.0.

- C. Perlite: Horticultural Perlite, soil amendment grade, 6.5 to 7.5 pH.

1. Unacceptable Materials: Polystyrene beads shall not be used as a substitution for horticultural Perlite.

- D. Vermiculite: Horticultural Vermiculite, gold-brown in color.

- Size: 2-4mm, 5 mesh to 10 mesh sieve size.
- Density: 4.5 to 5.5 lb./cu ft.
- Grade: #2, Medium Grade.

2.03 INORGANIC PLANTING SOIL AMENDMENTS

- A. Peat Humus:

- Type: Canadian Sphagnum Peat, as derived from the genus Sphagnum, medium-divided, coarse fibrous texture, brown in color.
- Measurement: Measure peat in air dry condition, containing not more than 35% moisture by weight on an "as-received" basis.
- Physical Properties:

Percent Passing	Sieve Designation
95 – 100%	9.51 mm (3/8")
0 – 40%	500 micron (No.35)

- Organic Content (dry weight basis): Minimum 95%.
- Fiber Content: Greater than 66%.
- Water Holding Capacity: 20x to 30x its dry weight in water.
- Range in Ash Content (%): 1.0 to 5.0.
- Chemical Properties:

- Nitrogen (dry weight basis): 0.6-3.0%.
- Salinity/Soluble Salts: Saturation extract conductivity 0.0-3.0 millimhos/cm @ 25 degrees C.
- pH range: 3.0 to 4.0.

9. Unacceptable Materials:

- Coir Dust.
- Sedge Peat.
- Reed Peat.
- Hypnum Peat.

- B. Mycorrhizal Inoculum:

1. Mycorrhizal Inoculum for Plant Material: Dual soil-conditioning biological inoculum system of endo-and ecto- Mycorrhizal, used to further aid the plants ability to efficiently uptake available soil nutrients and increase resistance to drought.

- a. Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1) 7-gram Myco-Pak, Tri-C Enterprises LLC, Chino, CA, 800-927-3311.
 - 2) 4 oz. Packet - Roots 1 Step, Roots, Inc., Independence, MO, 800-342-6173.
 - 3) Or equal, as approved by the Landscape Architect.
- b. Provide at the prescribed application rate, per the Manufacturer's written recommendations.

2.04 CHEMICAL SOIL AMENDMENT COMPONENTS

- A. General: Chemical Soil Amendment Components listed herein may or may not be used, depending on the results of the Agronomic Soil Fertility Report. Provide as required.
- B. Gypsum: Commercially-processed and packaged agricultural-grade hydrated calcium sulfate product (CaSO_4), 92.0% minimum, pH at 7.1.
 - 1. Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Ben Franklin® No. 1 Agricultural Gypsum, U.S. Gypsum Company.
 - b. 100% Good Stuff Gypsum™, Art Wilson Company.
 - c. CAL-SUL® Pelletized Agricultural Gypsum, North Pacific Group.
 - d. Bumper Harvest Agricultural Gypsum, Domtar Gypsum.
 - e. Premium 97 Solution-Grade Gypsum, Diamond K, Inc.
 - f. Or equal, as approved by the Landscape Architect.
- C. Soil Sulfur: Elemental Sulfur (90% min.) commercially manufactured, water degradable, palletized.
 - 1. Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Disper-Sul, Martin Resources, Inc.
 - b. Soil Sulfur, Red Top.
 - c. Or equal, as approved by the Landscape Architect.
- D. Iron: Non-staining, 40% Fe minimum, complete with micro-nutrients and 2% humic acids, as derived from iron oxide, manganese oxide, or zinc oxide.
 - 1. Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Gro-Power Iron, Gro-Power, Chino, CA.
 - b. Iron 45 w/ Micronutrients, Tri-C Enterprises LLC, Chino, CA.
 - c. Or equal, as approved by the Landscape Architect.
- E. Dolomite Lime: Agricultural-grade mineral soil conditioner containing 35% minimum magnesium carbonate, and 49% minimum calcium carbonate, 100% passing #65 sieve.
- F. Potassium Sulfate (Sulfate of Potash K_2O), (0-0-50 guaranteed analysis N-P O_5 -K O): Agricultural-grade, containing minimum 50% of water-soluble potash and 18% Sulfur (S).
- G. Single Superphosphate P_2O_5 (0-15-0 guaranteed analysis N-P O_5 -K O): Commercial product, containing 15% available phosphoric acid and 14% Sulfur.
- H. Triple Superphosphate P_2O_5 , (0-45-0 guaranteed analysis N-P O_5 -K O): Commercial product, containing 45% available phosphate and 15% Calcium (Ca).
- I. Ammonium Sulfate $(\text{NH}_4)_2\text{SO}_4$, (21-0-0 guaranteed analysis N-P O_5 -K O): Commercial product containing approximately 21% ammonia.
- J. Ammonium Nitrate NH_4NO_3 , (34-0-0 guaranteed analysis N-P O_5 -K O): Commercial product containing approximately 34%

ammonia.

- K. Calcium Nitrate CaNO_3 , (15.5-0-0 guaranteed analysis N-P₂O₅-K₂O): Agricultural grade containing 15-1/2% nitrogen.
- L. Potassium Nitrate KNO_3 , (13-0-45 guaranteed analysis N-P₂O₅-K₂O): Commercial product containing approximately 13% nitrogen and 45% potassium.
- M. Ureaformaldehyde (38-0-0 guaranteed analysis N-P₂O₅-K₂O): Granular commercial product containing approximately 38% nitrogen.
- N. Urea $\text{CO}(\text{NH}_2)_2$, (46-0-0 guaranteed analysis N-P₂O₅-K₂O): Granular commercial product containing 46% nitrogen.
- O. I.B.D.U. (Iso Butyldiene Diurea): Commercial product containing 31% nitrogen.

2.05 FERTILIZER

- A. Composition: Nitrogen (N), phosphorous (P₂O₅), and potassium (K₂O) content, plus other elements, as indicated.
- B. Fertilizer Tablet:

1. General: Fertilizer Tablet shall be a 7-gram tablet, organic-based, tightly compressed chip-type commercial grade, 12-month slow-release planting tablets, and shall be composed of the following available percentages by weight of plant food:

Element/Material	Targeted Property Range
Nitrogen (N)	12% Minimum
Phosphoric Acid (as P ₂ O ₅)	8% Minimum
Potash (as K ₂ O)	8% Minimum
Humus	20% Minimum
Humic Acids w/ micronutrients and soil enhancers	4% Minimum

2. Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Gro-Power 12-8-8 Planting Tablets, Gro-Power.
 - 1) Application Rate: As indicated herein Part III this Section.
 - b. Or equal, as approved by the Landscape Architect.

2.06 ACCESSORIES

- A. Drain Rock/Aggregate: Crushed Stone, conforming to ASTM C33, graded to ¾"-size, clean, hard, durable, free of materials toxic to plant growth, set in bottom of Planters, at depth indicated in Contract Drawings. Provide Geotextile Filter Fabric between Drain Rock/Aggregate and amended planting backfill soil.
- B. Wetting Agent/Water Storing Polymer: Non-biodegradable, granular, polyacrylamide polymer soil amendment.
 1. Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, approved through submittal.
- C. Landscape Mulch Material:
 1. Organic Wood Mulch: Triple Hammered Hardwood Mulch
 2. Decomposed Granite: 5/8" Canyon Gold from Blessing Gravel. Tishomingo, OK.
 3. Landscape Mulch Material for Submersible Planting Pots: Native River Cobble, to be approved through submittal.

PART 3 - EXECUTION

3.01 AGRONOMIC SOIL FERTILITY REPORT/RECOMMENDATION

SOIL PREPARATION

- A. Once rough grading has been accomplished, and prior to commencing Soil Preparation operations, (amendments, fertilizers, etc.), soil samples shall be taken from representative areas and below grade depths of the Project Site. Locations and depths to gather the representative soil samples shall be accomplished by the Contractor under the direction of the Landscape Architect.
1. Provide a minimum of ten (10) Soil Samples from locations to be coordinated.
- B. Guidelines for Selecting the Soil Samples:
1. Select representative areas to sample. The area needs to be uniform in color, texture, depth, and drainage with the same fertilizing program and type of use. Planting areas to receive lawns, flowerbeds, trees, cut areas, fill areas, etc. should be tested separately. An area containing multiple trees and shrubs can be grouped into one area if the planting is the same.
 2. Depths and process of soil sampling:
 - a. Sample as deep as the soil will be amended, generally six-inches (6") deep for groundcover/lawns, eighteen-inches (18") deep for shrub areas, twenty-four-inches (24") deep for small boxed trees, and three-feet (3') to four-feet (4') for large boxed trees.
 - b. Use a soil probe or soil auger to remove a core sample; otherwise, use a shovel to dig a hole to the desired depth. Sample the soil from the side of the excavated hole, scraping the side with a trowel. The tools used for digging shall be clean and not rusty. Avoid sampling when the soil is too wet.
 3. In desired areas where multiple sub-samplings are taken from any one (1) area to create a combined sample, mix the sub-samples homogenously together in a clean plastic bucket prior to placing in the plastic bag.
 4. Each Sample shall be sent directly to the laboratory in a separate, re-sealable, one (1)-gallon plastic bag. Provide a minimum of four (4) cups of soil within each respective sample to allow for adequate testing.

3.02 SOIL PERCOLATION TESTING

- A. Type/Quantity: During operations of Agronomic Soil Fertility Testing and prior to installing Plant Material, Contractor shall perform Soil Percolation Tests, through the direction of the Landscape Architect, in selected representative areas of the Project Site, to verify acceptable natural drainage, soil structure, and soil composition. Contractor shall verify the locations of the Soil Percolation Tests with the Landscape Architect.
1. Required Number of Soil Percolation Tests: ten (10)
- B. Procedure: Each Soil Percolation Test shall be performed as follows:
1. Dig a hole: 2'-0" wide x 2'-0" long x 2'-0" deep.
 2. Fill the hole with water to top and cover with plywood and barricade. Allow hole to drain and fill again to top.
 3. Make daily observations, noting the depth of water each day.
 4. Report findings, in writing, to the Landscape Architect. Include the length of time the water takes to drain completely from each hole, date of test, location, and other information, which may be useful in providing further recommendations.
- C. Results: Based on the combined results of the Agronomic Soil Fertility Testing and the Soil Percolation Tests, Contractor may be required to install additional tree drainage sumps or other drainage methods at each planting pit for trees larger than 15-gallon container stock. Contractor shall include, as a line-item price within the Base Bid, the price per each additional tree drainage sump, should they be required (based on the testing).

3.03 SOIL MOISTURE CONTENT

- A. General: Do not work soil when moisture content is so great that excessive compaction occurs, or when it is so dry that dust will form in air, or that clods will not break readily. Apply water, if necessary, to bring soil to an optimum moisture content for tilling and planting. Soil moisture level prior to planting shall be no less than 75% of field capacity. The determination of adequate soil moisture for planting shall be the judgment of the Landscape Architect. Range: Maintain within two-percent (2%) above or below optimum moisture content at times during Work.

3.04 CLEARING, CULTIVATION, & EXCAVATION

- A. Clearing: Clear planting areas free of stones two-inches (2") in diameter and larger, weeds, debris, and other extraneous materials prior to soil preparation Work.
- B. Pre-Plant Weed Control:
1. Clear and remove existing weeds by spraying and grubbing to at least one-inch (1") below the soil surface.

2. Dead weeds shall be cleared and removed prior to planting.
3. Maintain a weed-free Project Site until final acceptance by the Owner, utilizing mechanical, chemical, or manual treatment.

C. Cultivation of Native Site, with Amendments/Fertilizers:

1. Verification: In planting areas where Native Topsoil blend will be applied, verify that sub-grades prior to installation of Topsoil have been established under rough grading. Do not spread Topsoil prior to acceptance of sub-grade Work.
2. Cultivation: Following Pre-Plant Weed Control operations, rip or cultivate verified planting areas of Native Site Soil at the indicated depth, prior to applying Imported Topsoil (if required) and Soil Amendments/Fertilizers.
 - a. Depth of Cultivation for existing soils: As specified in Drawings or minimum 8-inches (8").
 - b. Depth of Excavation for imported soils: As specified in Drawings or minimum 8-inches (8").
3. Following initial cultivation or excavation of existing Native Site Soil, evenly spread Imported Topsoil (if required) throughout all planting areas at the minimum indicated depth to meet finished landscape grades.
 - a. Depth of Imported Topsoil: As indicated on the Drawings.
 - b. Minimum of eight-inch (8") at Landscape Beds or Mass Planting areas.
 - c. Minimum of four-inches (4") at Sodded areas.
 - d. Minimum of two-inches (2") at Permanent Seeded areas.
4. Once Imported Topsoil has been spread, uniformly broadcast all required Soil Amendments and Fertilizers as recommended through the results of the Agronomic Soil Fertility Report.
5. Thoroughly cultivate/blend all materials to provide a homogenous planting soil mixture at the indicated depth:
 - a. Depth of Cultivation: Minimum eight-inches (8").
6. Lightly tamp/compact prepared Planting Soil to eliminate settlement, and complete finish grading operations.
7. Planting Soil Amendment Schedule: The Planting Soil Amendment Schedule shall be based on the combined results of the Agronomic Soil Fertility Tests and Percolation Tests and recommendations provided by the Testing Agency/Lab.

3.04 APPLICATION RATES

- A. Fertilizer Tablets shall be spread equidistantly around the perimeter within the Amended Planting Backfill Mixture, up to within three-inches (3") of the finished grade of the Mixture, and at the following rates:

Size of Plant Material	Total Quantity of 7-gram tablets
One (1)-gallon Container stock.	One (1) Tablet
Five (5)-gallon Container stock.	Nine (6) Tablets
Fifteen (15)-gallon container stock	Fifteen (10) Tablets
2.5" Caliper Stock	Fifteen (15) Tablets
3"-4" Caliper Stock	Twenty-two (22) Tablets
5"-8" Caliper Stock	Thirty-six (30) Tablets

1. Contractor shall not provide Fertilizer Tablets for designated native plant species, if directed by the Landscape Architect. Contractor shall verify with the Landscape Architect, in writing, as to which plants are subject to not receive the Fertilizer Tablets.

B. Mycorrhizal Inoculum Application Rate:

1. During application of Fertilizer/Planting Tablets, Mycorrhizal Inoculum shall be spread equidistantly around the perimeter within the Amended Planting Backfill Mixture, up to within three (3") inches of the finished grade of the Mixture, at the prescribed application rate per the Manufacturer's written recommendations.

3.05 DRAINAGE OF PLANTING AREAS

A. Surface Drainage:

1. Discrepancies: Provide proper surface drainage of planted areas. Submit in writing all discrepancies in the Contract Drawings or Specifications, or prior Work done by others, which Contractor feels precludes establishing proper drainage.
2. Correction: Include description of work required for correction or relief of said condition.

B. Detrimental Drainage, Soils and Obstructions:

1. Notification: Submit in writing all soils or drainage conditions considered detrimental to growth of plant materials. State condition and submit proposal and cost estimate for correcting condition.
2. Correction: Submit for acceptance a written proposal and cost estimate for the correction before proceeding with Work.
3. Obstructions: If rock, underground construction Work, tree roots, or other obstructions are encountered in the performance of Work under this Section, submit cost required to remove the obstructions to a depth of not less than six-inches (6") below the required soil depth.

3.06 MAINTENANCE

- A. Protect graded areas from traffic and erosion. Keep free of trash and debris. Repair and reestablish grades in settled, eroded, and damaged areas.
- B. Where completed areas are disturbed by construction operations or adverse weather, scarify surface, reshape, and compact to required density.

3.07 WASTE MATERIALS

- A. Haul from site and legally dispose of waste materials including trash and debris as required and approved by the owner typical.

3.08 CLEAN UP

- A. Upon completion of filling and grading work, remove equipment and tools. Leave site clear, clean, free of debris and ready for subsequent trades work.

END OF SECTION 319133

SECTION 329200 - TURF GRASSES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide sodded lawns as shown and specified. The work includes:

1. Soil preparation.
2. Sodding lawns and other indicated areas.
3. Maintenance.

1.02 QUALITY ASSURANCE

A. Sod: Comply with American Sod Producers Association (ASPA) classes of sod materials.

B. Provide and pay for materials testing. Testing agency shall be acceptable to the Architect.
Provide the following data:

1. Test representative materials samples proposed for use.
2. Topsoil:
 - a. pH factor.
 - b. Mechanical analysis.
 - c. Percentage of organic content.

- d. Recommendations of type and quantity of additives required to establish satisfactory pH factor and supply of nutrients to bring nutrients to satisfactory level for planting.

1.03 SUBMITTALS

- A. Submit sod growers certification of grass species. Identify source location.
- B. Submit the following materials certification:
 - 1. Fertilizer(s) analysis.
- C. Submit materials test report.
- D. Upon sodded lawn acceptance, submit written maintenance instructions recommending procedures for maintenance of sodded lawns.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Cut, deliver, and install sod within a 24-hour period.
 - 1. Do not harvest or transport sod when moisture content may adversely affect sod survival.
 - 2. Protect sod from sun, wind, and dehydration prior to installation.
 - 3. Do not tear, stretch, or drop sod during handling and installation.

1.05 PROJECT CONDITIONS

- A. Work notification: Notify Architect at least 7 working days prior to start of sodding operations.
- B. Protect existing utilities, paving, and other facilities from damage caused by sodding operations.
- C. Perform sodding work only after planting and other work affecting ground surface has been completed.
- D. Restrict traffic from lawn areas until grass is established. Erect signs and barriers as required.
- E. Provide hoses and lawn watering equipment as required.

1.06 WARRANTY

- A. Provide a uniform stand of grass by watering, mowing, and maintaining lawn areas until final acceptance. Re sod areas, with specified materials, which fail to provide a uniform stand of grass until all affected areas are accepted by the Landscape Architect.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Reference plan for turf material type.

- B. Provide well-rooted, healthy sod, free of diseases, nematodes and soil borne insects. Provide sod uniform in color, leaf texture, density, and free of weeds, undesirable grasses, stones, roots, thatch, and extraneous material; viable and capable of growth and development when planted.
- C. Fertilizer:
 - 1. Granular, non-burning product composed of not less than 50% organic slow acting, guaranteed analysis professional fertilizer.
 - a. 8-8-8.
 - b. 10-10-10.
- D. Water: Will be may not be available on site. Landscape contractor will provide necessary hoses and other watering equipment required to maintain and complete work. An automatic/drip irrigation system will be installed simultaneously with the landscape planting. The landscape contractor shall not anticipate the use of the irrigation system during installation of this contract.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine finish surfaces, grades, topsoil quality, and depth. Do not start sodding work until unsatisfactory conditions are corrected.

3.02 PREPARATION

- A. Limit preparation to areas which will be immediately sodded.

- B. Loosen topsoil of lawn areas to minimum depth of 4". Remove stones over 1" in any dimension and sticks, roots, rubbish, and extraneous matter.
- C. Grade lawn areas to smooth, free draining and even surface with a loose, uniformly fine texture. Roll and rake; remove ridges and fill depressions as required to drain.
- D. Apply Type A fertilizer at the rate equal to 1.0 lb. of actual nitrogen per 1,000 sq. ft. (220 lbs./acre). Apply fertilizer by mechanical rotary or drop type distributor, thoroughly and evenly incorporated with the soil to a depth of 3" by disking or other approved methods. Fertilize areas inaccessible to power equipment with hand tools and incorporate it into soil. Buffalo Grass Sod may not require fertilizer submit soil test for review by Landscape Architect.
- E. Dampen dry soil prior to sodding.
- F. Restore prepared areas to specified condition if eroded, settled, or otherwise disturbed after fine grading and prior to sodding.

3.03 INSTALLATION

- A. Sodding:
 - 1. Lay sod per plans to form a solid mass with tightly-fitted joints. Butt ends and sides of sod strips. Do not overlay edges. Stagger strips to offset joints in adjacent courses. Remove excess sod to avoid smothering of adjacent grass. Provide sod pad top flush with adjacent curbs, sidewalks, drains, and seeded areas.
 - 2. Do not lay dormant sod or install sod on saturated or frozen soil.
 - 3. Install initial row of sod in a straight line, beginning at bottom of slopes, perpendicular to direction of the sloped area. Place subsequent rows parallel to and lightly against previously installed row.

4. Peg sod on slopes greater than 3 to 1 to prevent slippage at a rate of 2 stakes per yd. of sod.
 5. Water sod thoroughly with a fine spray immediately after laying.
 6. Roll with light lawn roller to ensure contact with sub-grade.
- B. Sod indicated areas within contract limits and areas adjoining contract limits disturbed as a result of construction operations.

3.04 MAINTENANCE

- A. Maintain sodded lawn areas, including watering, spot weeding, mowing, application of herbicides, fungicides, insecticides and resodding until a full, uniform stand of grass free of weed, undesirable grass species, disease, and insects is achieved and accepted by the Architect at the completion and acceptance of the entire project.
1. Water sod thoroughly every 2 to 3 days, or as required to establish proper rooting.
 2. Repair, rework, and resod all areas that have washed out or are eroded. Replace undesirable or dead areas with new sod.
 3. Mow lawn areas as soon as lawn top growth reaches a 3" height. Cut back to 2" height. Repeat mowing as required to maintain specified height. Not more than 40% of grass leaf shall be removed at any single mowing.
 4. Apply Type B fertilizer to lawns approximately 30 days after sodding at a rate equal to 2.0 lbs. of actual nitrogen per 1,000 sq. ft. (140 lbs./acre). Apply with a mechanical rotary or drop type distributor. Thoroughly water into soil. *Only as required per soil test for Buffalo Sod
 5. Apply herbicides as required to control weed growth or undesirable grass species.
 6. Apply fungicides and insecticides as required to control diseases and insects

3.05 ACCEPTANCE

- A. Inspection to determine acceptance of sodded lawns will be made by the Architect, upon contractor's request at the completion of the entire project. Provide notification at least 10 working days before required inspection date.
 - 1. Sodded areas will be acceptable provided all requirements, including maintenance, have been complied with, and a healthy, even colored viable lawn is established, free of weeds, undesirable grass species, disease, and insects.
- B. Upon final acceptance, the Owner will assume lawn maintenance.

3.06 CLEANING

- A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, debris, and equipment. Repair damage resulting from sodding operations.

END OF SECTION 32920

Missouri State University

Judith Enyeart Reynolds
Complex

08/08/24

SECTION 329300 – EXTERIOR PLANTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work Included: Provide trees, shrubs, ground covers, native perennials, native grasses and native wildflower and grass seed as shown and specified.

1. Soil preparation.
2. Trees, shrubs, groundcovers, native perennials and native grasses.
3. Planting mixes.
4. Mulch and planting accessories.
5. Maintenance and Extended Management.

- B. Related work:

1. Section 01 5713: Temporary Erosion and Sediment Control
2. Section 32 8400: Planting Irrigation
3. Section 32 9200: Turf Grasses
4. Section 32 9400: Landscape Planting Accessories
5. Section 31 2100: Finish Grading
6. Section 32 9400: Soil Preparation

- C. Definitions:

1. Plant Material(s) – Refers to living plant species, inclusive of trees, shrubs, groundcovers, vines, ornamental grasses, cacti/succulents, espaliers, annuals, perennials, etc., as indicated in the Contract Drawings.
2. Planting Area (PA) – As denoted on the Contract Drawings, shall refer to areas to be installed with Plant Material(s), or areas where existing vegetation shall be protected.
3. Plant Height – Measurement of main body height, not measurement to branch tip.
4. Plant Spread – Measurement of main body diameter, not measurement from branch tip to branch tip.
5. Amended Planting Backfill Mixture – Refer to Section 32 91 13 – Soil Preparation.
6. Balled and Burlapped Stock – Healthy, vigorous exterior plants with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum laced as recommended by ANSI Z60.1.
7. Balled and Potted Stock – Healthy, vigorous exterior plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of exterior plant required.

8. Bare-Root Stock – Healthy, vigorous exterior plants grown with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of exterior plant required.
10. Compacted Settling Layer – Subgrade under where a plant is directly planted.
11. Container-Grown Stock – Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of exterior plant required.
12. Fabric Bag-Grown Stock – Healthy, vigorous, well-rooted exterior plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of exterior plant.
13. Finish Grade – Elevation of finished surface of planting soil.
14. Manufactured Topsoil – Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
15. Multi-Stem – Where three (3) or more main stems arise from the ground from a single root crown or at a point right above the root crown.
16. Sub-grade – Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.
17. Subsoil – All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

1.02 QUALITY ASSURANCE

A. Installer Qualifications:

1. Requirement: Valid Arkansas Landscaping Contractor License.
2. Engage an experienced Installer who has demonstrated completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful landscape establishment.
3. Installer's Field Supervision: Installer shall maintain an experienced full-time supervisor on the Project site during times that landscaping installations under this Section are in progress.
4. Selections of Plant Material may be sourced and purchased by the Owner directly. Contractor to provide a line item installation cost and separate warranty identifying the schedule of values for each.

B. Plant Material:

1. Trees, Shrubs, Grasses and Seed: Provide quality, size, genus, species, and variety of Plant Material indicated, complying with applicable requirements of ANSI Z60.1

"American Standard for Nursery Stock."

- a. At least one (1) plant of each Plant Material species delivered to the Project Site shall have an identification tag from supplying nursery showing botanical and common name of the plant as identified in the Contract Drawings. Landscape Architect shall be provided the opportunity for an on-site debriefing by the Contractor that identifies the size and specific type of Plant Material upon delivery.
 - 1.) Incorrect Planting Materials:
 - a.) Replace, at no cost to Owner, Plant Material that is revealed during the course of the Contract as to being untrue to the species indicated in the Contract Drawings and reviewed accordingly under this Section.
 - b.) Provide replacements equal to the size and quality to match the planted materials at the time the untrue species is discovered.
 - 2.) Replacement of Plant Material: Refer to the Guarantee Article indicated herein this Section.
2. Native Wildflower and Grass seed: Provide quality seed and/or custom mix identified within the Construction Documents. Noxious weed seeds shall not exceed one-half (1/2) percent by weight of the total of pure live seed and other material in the mixture. Johnson Grass, nutgrass or other noxious weed seed will not be allowed.
 - a. At least one-half (1/2) pound of each seed/seed mix species delivered to the Project Site shall have an identification tag from supplying nursery showing botanical and common name of the plant as identified in the Contract Drawings. Landscape Architect shall be provided the opportunity for an on-site debriefing by the Contractor to verify the species of seed upon delivery.
 - 1.) Incorrect Seed Materials:
 - a.) Replace, at no cost to Owner, Seed that is revealed during the course of the Contract as to being untrue to the species indicated in the Contract Drawings and reviewed accordingly under this Section.
 - b.) Provide replacement seed at the time the untrue species is discovered.
 - 2.) Replacement of Plant Material: Refer to the Guarantee Article indicated herein this Section.

- C. Observation: Landscape Architect may observe Plant Materials at their place of growth (nursery), at the site before or after planting, or both, for compliance with requirements for genus, species, variety, size, and quality. Landscape Architect also retains right to observe Plant Material further for size and condition of root balls, trunks, branches, and crowns; insects; pests; disease; weeds; injuries, and latent defects. Landscape Architect reserves the right to reject unsatisfactory and/or defective Plant Material at any time during progress of Work. Contractor shall remove rejected Plant Material immediately from Project site.
- D. Regulatory Requirements:
1. Contractor shall meet the requirements of applicable laws, codes, and regulations as required by the authorities having jurisdiction over the Work. Plant names indicated, comply with "Standardized Plant Names" as adopted by the latest edition of the American Joint Committee of Horticultural Nomenclature. Names of varieties not listed conform generally with names accepted by the nursery trade. Provide stock true to botanical name and legibly tagged.
- E. Permits, Fees, Bonds, and Inspections: Contractor shall arrange and pay for permits, fees, bonds, and inspections necessary to perform and complete Work under this Section.
- F. Plant Material Review and Selection (Tagging):
1. At the discretion of the Landscape Architect, Plant Material will be subject to review, photographed, and selected/tagged by the Landscape Architect at the nursery, or other place of growth, prior to delivery to the Project Site. Contractor shall verify with the Landscape Architect if tagging operations are required.
 2. Selecting/Tagging of Plant Materials at the nursery or place of growth does not cancel the right of the Landscape Architect to reject Plant Materials at the Project Site, if damaged or unacceptable conditions are found that were not detected at the nursery, place of growth, or in the submitted photographs.
- G. Plant Material Delivery: Plant Material shall be delivered with original Plant Material tagging materials set in place, as selected, and marked by the Landscape Architect at the nursery or place of growth. Seed, topdressing, and any fertilizer materials shall be delivered in original containers. Include materials showing weight, analysis, and names of growers. Store all seed material in a manner to prevent wetting, excessive heating, or other deterioration. Contractor shall notify Landscape Architect upon delivery of Plant Material for review of stock and tagging materials. Plant Materials delivered without original tagging materials, or with broken, damaged, or altered tagging materials, shall be subject to rejection by the Landscape Architect. Rejected Plant Material shall be removed immediately.

H. Pre-installation Conference: Conduct conference at Project Site.

I. Protection of Existing Plant Material:

1. Refer to Requirements specified in Section 015639 – Temporary Tree and Plant Protection.
2. It is the intent of the Contract Documents that certain existing Plant Materials shall be retained. Prior to the removal of any Plant Materials, the Contractor shall confer with the Landscape Architect to determine which Plant Materials are to remain.
3. All existing Plant Materials which are to remain in the project shall be tagged and identified by the Contractor prior to start of Work.
4. Contractor shall be responsible for Plant Materials that are designated to remain. Damage to any Plant Materials which results in death or permanent disfiguration of said Materials shall result in compensation outlined in Section 01 56 39 – Temporary Tree and Plant Protection. The Landscape Architect shall be the sole judge of the condition of the Plant Materials.
5. Existing Plant Materials designated to remain shall be protected at all times from damage by construction activity (tools, materials, equipment, personnel, etc.). Damage by the Contractor to existing Plant Materials shall be repaired at the Contractor's expense to the satisfaction of the Owner, as directed by the Landscape Architect.
6. Contractor shall insure that no foreign material and/or liquid, such as paint, concrete, cement, oil, turpentine, acid or the like, be deposited or allowed to be deposited on soil within the drip line (the outside edge of the foliage overhang) of any Plant Material. Do not store construction materials, debris, or excavated material within drip line of existing Plant Material. Should any such poisoning of the soil occur, the Contractor shall thoroughly remove said soil as directed by the Landscape Architect and replace with acceptable soil at no additional cost to the owner.
7. Excavation adjacent to existing Plant Materials: Where it is necessary to excavate in close proximity to the drip lines of existing Plant Materials, all possible caution shall be exercised to avoid injury to roots and trunk. Excavation close to Plant Materials shall be done by hand, with narrow-tine spading forks or other approved tools to comb soil to expose roots. Tunnel under roots two-inches (2") and larger in diameter. Cutting of roots two-inches (2") and larger shall be only on the approval of the Landscape Architect.
8. Replacement of Damaged Plant Material: Replace existing Plant Material to remain as required, that are damaged by Contractor during construction with accepted Plant Material of the same species, size, and quantity as those damaged, at no additional cost to Owner. Owner shall be the sole judge as to the extent of the damage and the value of said damaged Plant Material.

1.03 SUBMITTALS

A. General:

1. Collect information into a single submittal.
2. Submittal shall be organized and presented into specific sections or headings. Furnish neat, concise, legible, and clearly identifiable information, and sufficiently explicit detail, to enable proper evaluation for Contract compliance. Highlight catalog, product data, or brochures containing various products, sizes, and materials to show particular item submitted.
3. Submittal Format: As applicable, furnish Submittal as a single electronic digital PDF (Portable Document Format) file.

B. Digital Submittal Information:

1. Alphabetized List of Plant Material.
2. submitted in the following format.
 - a. Project Name
 - b. Botanical Name
 - c. Common Name
 - d. Container Size
 - e. Overall Height
 - f. Caliper Size
 - g. Quantity
3. The submittal shall not be construed as to acceptance of the plant material. All plant material shall be subject to review and approval by the Landscape Architect upon delivery to the project site.

C. No work shall proceed under this Section until submittal requirements indicated herein have been review accordingly by the Landscape Architect.

D. Provide plant material record drawings:

1. Legibly mark drawings to record actual construction.
2. Indicate horizontal and vertical locations, referenced to permanent surface improvements.
3. Identify field changes of dimension and detail and changes made by Change Order.

E. Submit for the Landscape Architect's approval five samples of each container grown plant under the number 15 container size. The five approved samples shall be retained in a protected location on the project site at a location approved by the General Contractor. The Landscape Contractor shall maintain the sample plants until completion of the site planting. The sample plants may then be used in the site planting.

1.04 DELIVERY, STORAGE, AND HANDLING.

- A. General: Do not prune Plant Material before delivery, except as approved by the Landscape Architect. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie Plant Material in such a manner as to destroy natural shape.
1. Immediately after digging field-grown Plant Materials, pack root systems in wet straw, hay, burlap, or other suitable material to keep root system moist until final planting installation.
 2. Deliver freshly dug field-grown Plant Materials with firm, natural balls of earth of sufficient depth to include fibrous and feeding roots, meeting, or exceeding requirements of ANSI Z60.1 for root ball diameter.
 3. Store all seed material in a manner to prevent wetting, excessive heat, or other deterioration.
- B. Handling Plant Materials:
1. Handle balled and burlap Plant Material stock by the root ball.
 2. Handle container-grown Plant Materials only by their containers.
 3. DO NOT handle Plant Materials by their trunks or stems.
 4. DO NOT drop any Plant Materials.
 5. DO NOT bind or handle Plant Materials with wire or rope.
 6. Pad trunk and branches of Plant Materials whenever using hoisting cables, chains, or straps.
 7. Should the Contractor engage in handling any Plant Material(s) by any unacceptable method(s), the Landscape Architect shall reserve the right to reject any of the mishandled Plant Material(s). The Contractor shall replace rejected Plant Material(s) with approved Plant Material(s), at no additional cost to the Owner.
- C. Delivery: Provide protective covering during delivery. Deliver Plant Material only after preparations for planting have been completed and install immediately. If planting is delayed more than six (6) hours after delivery, set Plant Materials in shade, protect from weather and mechanical damage, and keep roots moist. Anchor plants to prevent damage from winds.
1. Heel-in bare-root Plant Material stock. Soak roots in water for two (2) hours prior to planting.
 2. Set balled Plant Material stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 3. DO NOT remove container-grown Plant Material stock from containers before time of planting.

4. Water root systems of Plant Material stored on site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.05 PROJECT CONDITIONS

- A. Work notification: Notify Architect at least 7 working days prior to installation of plant material.
- B. Protect existing utilities, paving, and other facilities from damage caused by landscaping operations.
- C. A complete list of plants, including a schedule of sizes, quantities, and other requirements is shown on the drawings. In the event that quantity discrepancies or material omissions occur in the plant materials list, the planting plans shall govern.

1.06 WARRANTY

- A. Warrant plant material to remain alive and be in healthy, vigorous condition for a period of 1 year after completion and acceptance of entire project.
 1. A review of plants will be made by the Architect at Substantial Completion and Final Completion.
- B. Replace, in accordance with the drawings and specifications, all plants that are dead or, as determined by the Architect, are in an unhealthy or unsightly condition, and have lost their natural shape due to dead branches, or other causes such as bark abrasions and misuse of chemicals, due to the Landscape Contractor's negligence. The cost of such replacement(s) is at Landscape Contractor's expense. Warrant all replacement plants for 1 year after installation.
- C. Warranty shall not include damage or loss of trees, plants, or ground covers caused by fires, floods, freezing rains, lightning storms, or winds over 75 miles per hour, winter kill caused by extreme cold and severe winter conditions not typical of planting area, acts of vandalism or negligence on the part of the owner.
- D. Remove and immediately replace all plants, as determined by the Architect, to be unsatisfactory during the initial planting installation.

PART 2 - PRODUCTS

2.01 MATERIALS

EXTERIOR PLANTS

- A. Immediately upon award of Contract for Work in this Section, Contractor shall locate and purchase or hold for purchase plant material as required.
 - 1. Contractor shall verify with Landscape Architect of Plant Material that has been nursery "contract grown" by the Owner for use of Work under this Contract.
 - 2. Contractor shall review the condition of the Plant Material with Landscape Architect at the nursery maintaining the Plant Material prior to delivery, and when delivered to the Project Site.
- B. Quality: Plant Materials shall have a growth habit typical for each variety and species indicated in the Plant List (as detailed on the Contract Drawings).
 - 1. All Plant Materials specified shall be superior/premium-grade nursery stock, full, densely foliated, symmetrical, with tightly knit branching, so trained or favored in development and appearance in form, number of branches, compactness and symmetry, healthy, and vigorous in growth, as reviewed and determined by the Landscape Architect.
 - 2. Plant Materials shall be free from insect pests, eggs and larvae, plant diseases, sun scalds, fresh bark abrasions, excessive abrasions, windburn, salt burn, weeds, or other disfigurements or conditions, as reviewed and determined by the Landscape Architect.
 - 3. Plant Material shall be subject per the Arkansas State Department of Agriculture's Regulations for Nursery Inspections of Rules and Grading.
 - 4. Growing Conditions: Plant Materials shall be nursery-grown in accordance with good horticultural practices under climatic conditions similar to those of project unless otherwise specifically authorized.
- C. Container Stock (excluding annuals) shall be grown in boxes or containers in which delivered for at least one (1) growing season, but not over two (2) years. Plant Material grown in boxes or containers shall be cultivated during this time to permit full rooting within the specified box or container to bind the planting soil, but not so long as to create a "root-bound" condition.
 - 1. Plant Material shall be completely free of circling, kinked or girdling trunk surface and center roots, and show no evidence of a pot-bound condition.
 - 2. No boxed nor container Plant Material shall be planted which have cracked or broken balls of earth when separated from their boxes or containers.
 - 3. No Plant Material shall be planted with damaged roots, broken root balls, or which are found to be "root-bound" when separated from their containers.
- D. Pruning:
 - 1. Do not prune Plant Materials unless directed by the Landscape Architect.

2. Pruning of Plant Material as grown at the nursery shall conform to ANSI A300 Standards.
3. Consult with Landscape Architect for pruning Plant Materials after delivery and installation.

E. Measurements: Measure Plant Material according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes.

1. Take caliper measurement at a point on the trunk six-inches (6") above natural ground line for trees up to four-inches (4") in caliper (at a point twelve-inches (12") above the natural ground line for trees over four-inches (4") in caliper).
 - a. Measure foliage across mean foliage dimension when branches are in their normal upright position.
 - b. For trees to be supplied in "raised up" condition, foliage origin along main trunk shall be measured from soil line after installation.
 - c. Height and spread dimensions specified refer to main body of plant and not branch tip to tip. Properly trimmed plants shall measure the same in any direction. If a plant is unevenly grown, it shall be classified in the size category of the smallest dimension.
2. Size Range: If a range of size is given, do not use Plant Materials less than the minimum size. The measurements specified are the minimum size acceptable and are the measurements after pruning, where pruning is required. Plant Materials that meet the measurements specified, but do not possess a normal balance between height and spread shall be rejected.

F. Field Dug Stock: Prior to digging of field-grown Plant Materials, ensure that excess loose fill resulting from cultivation around trunks/stems and over roots be removed down to natural finish grade at crown of Plant Materials. During digging, verify that size of tree spade or other equipment is adequate to encompass the actively growing root zone of all Plant Materials. Plant Materials which, after digging, show mostly large fleshy roots and few fibrous roots, will be rejected.

G. Condition of Root Systems: Plant Materials must prove to be completely free of circling, kinked or girdling trunk surface and center roots and show no evidence of a root-bound condition. Upon inspection by Landscape Architect at the job site, if five-percent (5%) or more of the plants of each species are found to contain kinked, circling or girdling roots, all plants of that species shall be rejected.

H. Unacceptable Trees: Trees that have damaged, broken, pruned, or crooked leaders will be rejected. Trees having a main leader shall not have been headed back. Trees with abrasions of the bark, sunscalds, disfiguring knots, or fresh cuts of limbs over 3/4 in. which have not completely callused will be rejected.

2.02 TREES

- A. Shade and Flowering Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, conforming to ANSI Z60.1 for type of trees required, subject to review and acceptance by the Landscape Architect. Container-grown trees will be acceptable and shall be subject to meeting ANSI Z60.1 limitation for container stock.
 - 1. Branching Height: 1/2 of tree height, unless otherwise indicated on Contract Drawings.
- B. Small Trees: Small upright or spreading type, branched, or pruned naturally according to species and type, and with relationship of caliper, height, and branching recommended by ANSI Z60.1, subject to review and acceptance by the Landscape Architect. Container-grown trees will be acceptable and shall be subject to meeting ANSI Z60.1 limitation for container stock.
 - 1. Form: As indicated on the Contract Drawings for individual selected species.
- C. Field Dug Specimen Trees:
 - 1. Form and Size: As specified on the Contract Documents for height, spread, and/or caliper, subject to review and acceptance by the Landscape Architect at the supplying nursery prior to delivery and installation. Provide superior quality, full, symmetrical, well-rooted, upright, spreading, with well-balanced crown.
 - 2. Throughout the duration of excavation, transport, delivery, storage, and installation, all Field Dug Specimen Trees shall have their root balls remain moist, firm and intact, with no damage. Provide metal cages, as required, to insure root ball stability. Any tree that exhibits a broken, damaged, or dry root ball at any time under the Contract shall be subject to immediate rejection by the Landscape Architect.

2.03 SHRUBS

- A. Form and Size: Shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of Shrub, subject to review and acceptance by the Landscape Architect. Container-grown Shrubs will be acceptable in lieu of balled and burlapped.
 - 1. Container-grown Shrubs shall be subject to meeting ANSI Z60.1 limitations for container stock, and other requirements as indicated on the Contract Drawings.

2.04 CONIFEROUS EVERGREENS

- A. Form and Size: Normal-quality, well-balanced, well-rooted, coniferous evergreens, of

type, height, spread, and shape required, subject to review and acceptance by the Landscape Architect.

1. Boxed or container-grown coniferous evergreens will subject to meeting ANSI Z60.1 limitations for container stock, and other requirements as indicated on the Contract Drawings.

2.05 BROADLEAF EVERGREENS

- A. Form and Size: Normal-quality, well-balanced, well-rooted , broadleaf evergreens, of type, height, spread, and shape required, subject to review and acceptance by the Landscape Architect.

1. Container-grown broadleaf evergreens shall be subject to meeting ANSI Z60.1 limitations for container stock, and other requirements as indicated on the Contract Drawings.

2.06 GROUNDCOVERS

- A. Provide ground covers full, established, and well-rooted in removable flats, containers, or integral peat pots, and with not less than the minimum number and length of runners required by ANSI Z60.1 for the container size indicated, and other requirements as indicated on the Contract Drawings, subject to review and acceptance by the Landscape Architect.

2.07 NATIVE GRASSES AND PLUGS

- A. Form and Size: High-quality, established, full, well-balanced, well-rooted, of type, height, spread, and shape required, subject to review and acceptance by the Landscape Architect.

1. Container-grown stock shall be subject to meeting ANSI Z60.1 limitations for container stock.

2.08 PERMANENT SEEDING

- A. Quantity/Weight per plans. An approved combination of Wildflower Seeds and Native Grass seed shall be supplied as custom mixes identified within the Construction Documents. Procure local genotype seed when and if available. Seed must be collected by lawful means and must come from a similar geographic region.

2.08 ACCESSORIES

- A. Reference – Section 32 94 00 Landscape Planting Accessories

2.09 PLANT LIST

- A. The plant list including quantities is located on the plans and is for reference only. It is the responsibility of the contractor to determine total quantities in conformance with the plans. Height of plants specified and height of lowest branches of trees is above soil line.

PART 3 - EXECUTION

3.01 INSPECTION

- A. No work under this section shall commence until submittals under this section have been reviewed accordingly by the Landscape Architect.
- B. Prior to commencing Work under this Section, Contractor shall examine previously installed Work from other trades and verify that such Work is complete and to the point where Work herein may commence properly. Do not proceed with Work until unsatisfactory conditions have been corrected.
- C. Installation practices of the Plant Materials shall be performed during those periods when weather and soil conditions are suitable and in accordance with locally accepted horticultural practices, as judged by the Landscape Architect.
 - 1. Soil moisture levels prior to planting shall be no less than seventy-five-percent (75%) of field capacity. The determination of adequate soil moisture for planting shall be in the sole judgment of the Landscape Architect, and their decision shall be final.
 - a. If the soil moisture level is found to be insufficient for planting installation, planting pits shall be filled with water and allowed to drain before commencing planting operations.
 - b. Any planting area that may become compacted in excess of eighty-five-percent (85%) relative compaction (due to construction operations or other activities during the Contract) shall be tilled and thoroughly cross-ripped to a minimum depth of nine-inches (9") to alleviate the condition, taking care to avoid all existing subsurface utilities, drainage, etc.
 - c. Do not commence planting installation prior to acceptance of Section 329113 –Soil Preparation.
- D. Contractor shall notify the Landscape Architect, in writing, on the anticipated commencement date and length of duration of the landscape installation.
- E. Preparation of Planting Installation: Lay out individual Plant Material locations and areas for multiple plantings. Stake locations, outline areas, and gain the Landscape Architect's acceptance prior to commencing physical planting installation.

- F. At the discretion of the Landscape Architect, Contractor shall make field adjustments to the planting layout, as required, per the direction of the Landscape Architect. Layout changes made accordingly shall be performed at no additional cost to the Owner.

G. No more Plant Materials shall be distributed in the planting area on any day than can be installed and watered on that day. Plant Materials shall be planted and watered immediately after the removal of their containers, as applicable.

H. Contractor shall protect existing and new improvements and systems installed prior to planting installation. Maintain protection in place until completion of Work and Landscape Establishment Period.

- I. Finish Grades for planting areas shall have been established (per Section 31 22 19 – Landscape Grading) prior to Work under this Section. Verify that grades are within one-inch plus or minus (1"±) of the required finish grade, and that all proper soil amendments and fertilizers have been furnished and installed accordingly as specified (per Section 329113 – Soil Preparation).

1. Maintain positive surface drainage of all planted areas throughout the duration of the Contract.

- J. Pre-Planting: Where Plant Materials are to be pre-planted to permit site improvements to be installed around them, Contractor shall be responsible for the accurate layout and placement of those Plant Materials, as measured to their centerlines. Confirm designated pre-planting operations with Landscape Architect prior to commencing Work. Contractor shall also be responsible for the protection of pre-planted Plant Materials while other Work is taking place around them. Provide automated irrigation, as necessary, prior to installation and functioning of irrigation systems (per Section 32 84 00 – Irrigation Systems).

3.02 EXCAVATION FOR PLANT MATERIAL

- A. General: Upon completion of applicable pre-planting soil preparation requirements indicated in Section 32 91 13 – Soil Preparation, excavate planting hole(s) for Plant Material with scarified vertical sides, with the bottom of the excavated hole slightly raised and compacted at the center to assist drainage and to minimize settlement of the Plant Material. Excavate holes according to the spacing alignment (i.e. hedge spacing, grid spacing, triangular spacing, etc.) and the on-center (O.C.) spacing intervals (i.e. 24" O.C. etc.) indicated on the Contract Drawings. Loosen any hard subsoil in the bottom of the excavation where evident, and remove all rocks greater than one-half-inch (1/2") in diameter, trash, debris, etc. Retain the excavated soil for use as part of the Amended Planting Backfill Mixture (as indicated in Section 32 91 13 – Soil Preparation).
- B. Planting areas that have not been excavated prior to planting.

1. Plug Plant Material:
 - a. Excavate at least four-inches (1") wider than the perimeter of the plug, and deep enough to allow setting of the roots on a compacted layer of native planting soil, where the top of the plant's root collar is one half-inch (1/2") higher than finished grade or as further directed by the Landscape Architect
2. Balled and Burlap Plant Material:
 - a. Excavate the planting hole to the width and depth indicated in the Contract Drawings. Depth of the planting hole includes the depth indicated for the compacted setting layer at the bottom of the excavation, where the top of the plant's root collar is two-inch (2") higher than finished grade or as further directed by the Landscape Architect:
 - b. Compacted Setting Layer: Provide a crown of a minimum six-inch (6") depth of native planting soil.
3. Container-Grown Plant Material:
 - a. Excavate the planting hole to the width and depth indicated on the Contract Drawings. Depth of the planting hole includes the depth indicated for the compacted setting layer at the bottom of the excavation, where the top of the plant's root collar is two-inch (2") higher than finished grade or as further directed by the Landscape Architect:
 - b. Compacted Setting Layer: Provide a crown of a minimum six-inch (6") depth of native planting soil.
4. Field Grown/Specimen Trees:
 - a. Excavate the planting hole to the width and depth indicated on the Contract Drawings. Depth of the planting hole includes the depth indicated for the compacted setting layer at the bottom of the excavation, where the top of the plant's root collar is three-inch (3") higher than finished grade or as further directed by the Landscape Architect:
 - b. Compacted Setting Layer: Provide a crown of a minimum six-inch (6") depth of native planting soil.
 - c. In areas where special subsurface drainage for planting is indicated, tie drainage pipes, as required, into the drain system.
 - d. Excavate planting hole at 3x the diameter of the rootball.
5. Permanent Seeding
 - a. Treat seed area with an aquatic approved herbicide two (2) weeks prior to

- scarifying or applying topsoil.
 - b. Lightly scarify existing topsoil and place seed directly on existing soil.
 - c. When existing topsoil has been removed during grading operations, place a minimum of three-inches (3") of topsoil (Reference Section 32 91 13) to provide an acceptable seeding substrate.
- C. Obstructions: Notify the Landscape Architect immediately if unexpected rock, debris, contaminants, obstructions, or other items that are detrimental to the healthy sustained growth of Plant Material is encountered in the excavation process.
- 1. Hardpan Layer: If encountered, drill six-inch (6") diameter holes into free-draining strata or to a depth of ten-feet (10'), whichever is less, and backfill with free-draining material.
- D. Drainage: Notify the Landscape Architect if subsoil conditions show evidence of unexpected water seepage or retention in planting holes.
- E. Time of planting:
- 1. Evergreen material: Plant evergreen materials between September 1 and November 1 or in spring before new growth begins. If project requirements require planting at times, other than winter months, plants shall be sprayed with anti-desiccant prior to planting operations.
 - 2. Deciduous material: Plant deciduous materials in a dormant condition. If deciduous trees are planted in-leaf, they shall be sprayed with an anti-desiccant prior to planting operation.

3.03 INSTALLATION

- A. Plug Plant Material: Set Plug Plant Material plumb and in center of the excavated hole, with top of root structure set properly at the adjacent finish grade as indicated. Set Plug Plant Material in the proper spacing and/or alignment(s) as indicated on the Contract Documents, or as further directed at the Project Site by the Landscape Architect.
- 1. Thoroughly soak the roots in clean water for a minimum of two (2) hours but no more than four (4) hours to fully hydrate the root mass. Do not soak above the root crown.
 - 2. Carefully place the Plant Material stock on the specified setting layer of compacted native soil, with the top of root mass set approximately one half-inch (1/2") above the finished grade to allow for settlement of the Plant Material within the excavated planting hole. Provide an orientation of the Plant Material that is confirmed and acceptable by the Landscape Architect.

3. Prepare the Amended Planting Backfill Mixture: Amend each cubic yard (cu/yd) of native soil excavated from the planting hole by incorporating and thoroughly mixing/blending the following:
 - a. $\frac{1}{4}$ yard of Bulk Composted Organic Soil Amendment Material (per Section 32 91 13 – Soil Preparation).
 - b. $\frac{1}{2}$ pound of Granular Soil Conditioning Material & Fertilizer (per Section 329113–Soil Preparation).
 - c. Add Mycorrhizal Inoculum to the excavated native soil, (per Section 329113 – Soil Preparation), per the Manufacturer’s latest printed instructions.
 - 1) Pending the results of the Agronomic Soil Fertility Report, the Amended Planting Backfill Mixture may be modified accordingly to include additional soil amendments or fertilizers (gypsum, iron, potash, etc.) or the ratios as indicated in the Mixture indicated above may be modified.
 - a.) The cost of providing modifications to the Amended Planting Soil Backfill Mixture (as recommended through the Agronomic Soil Fertility Report and as directed by the Landscape Architect) shall be borne by the Contractor.
4. Backfilling the excavated planting hole:
 - a. Place the Amended Planting Backfill Mixture around the Plant Material root mass in the excavated planting hole. Place the Mixture in six-inch (6”) lifts, tamping each lift accordingly to settle the Mixture and eliminate voids and air pockets.
 - b. Maintain the Plant Material plumb while working the Mixture around the root mass. When the planting hole is approximately half-backfilled, water thoroughly before placing the remainder of the Mixture.
 - c. Add the Fertilizer Tablets and other amendments, (per Section 329113 – Soil Preparation) as required, at the prescribed application rates (as indicated per Section 329113 – Soil Preparation) or if not indicated, per the Manufacturer’s latest printed instructions.
 - d. Place the final layers of the Amended Planting Backfill Mixture, tamping accordingly, to the top of the root mass.
 - e. Dish and tamp top of the Mixture to form a three-inch (3”) deep watering basin centered on the Plant Material’s trunk to the rim width of the planting hole.
 - f. Thoroughly mix together water and Plant Vitamin/Hormone Stimulant in application ratio as recommended by Stimulant Manufacture (per Section 329400 –Landscape Planting Accessories). Apply liquid matrix in sufficient quantity to thoroughly saturate the basin to settle the Mixture, and to eliminate

voids and air pockets. Should any portions of the root mass be exposed, add additional Mixture as needed to thoroughly cover the root mass.

5. Mulching: Apply mulch evenly at 1" at all plug installation locations. Refer to Section 32 94 00) – Landscape Planting Accessories for type and requirements.

B. Balled and Burlapped Plant Material: Set the Balled and Burlapped Plant Material plumb and in center of the excavated hole, with top of the root ball raised above adjacent finish grade as indicated. Set Balled and Burlapped Plant Material in the proper spacing and/or alignment(s) as indicated on the Contract Documents, or as further directed at the Project Site by the Landscape Architect.

1. Carefully place the Balled and Burlapped Plant Material stock on the specified setting layer of compacted native soil, with the top of root ball set two-inch (2") above the finished grade to allow for settlement of the Plant Material within the excavated planting hole. Provide the orientation of the Plant Material that is confirmed and accepted by the Landscape Architect. During the process of determining an acceptable orientation of the Plant Material, handle the Plant Material by its root ball; avoid handling the Plant Material by its trunk.
2. Once orientation is accepted, carefully remove the burlap and wire baskets from the tops of the root ball and partially from the sides, but do not remove from under the root ball. Do not damage the root ball or any part of the plant. Plant Material shall be rejected if the root ball is cracked or broken before or during the planting operation.
3. Prepare the Amended Planting Backfill Mixture: Amend each cubic yard (cu/yd) of native soil excavated from the planting hole by incorporating and thoroughly mixing/blending the following:
 - a. ¼ yard of Bulk Composted Organic Soil Amendment Material (per Section 32 91 13 – Soil Preparation).
 - b. ½ pound of Granular Soil Conditioning Material & Fertilizer (per Section 32 91 13– Soil Preparation).
 - c. Add Mycorrhizal Inoculum to the excavated native soil, (per Section 32 91 13 –Soil Preparation), per the Manufacturer's latest printed instructions.
4. Backfilling the excavated planting hole:
 - a. Place the Amended Planting Backfill Mixture around the root ball in the excavated planting hole. Place the Mixture in six-inch (6") lifts, tamping each lift accordingly to settle the Mixture and eliminate voids and air pockets.
 - b. Maintain the plant plumb while working the Mixture around the root ball. When the planting hole is approximately half-backfilled, water thoroughly before placing the remainder of the Mixture.

- c. Add the Fertilizer Tablets and other amendments, (per Section 32 91 13 – Soil Preparation) as required, at the prescribed application rates indicated herein this Article or if not indicated, per the Manufacturer's instructions.
 - d. Place the final layers of the Mixture, tamping accordingly, to the top of the root ball. Do not place the Mixture on top of the root ball. Pull soil away and exposed root flare. Ensure root flare is planted above finished grade.
 - e. Dish and tamp top of the Mixture to form a three-inch (3") deep watering basin centered on the Plant Material's trunk to the rim width of the planting hole. Do not cover the top of the root ball with the backfill mixture.
 - f. Thoroughly mix water and Plant Vitamin/Hormone Stimulant in application ratio as recommended by Stimulant Manufacture (per Section 32 94 00– Landscape Planting Accessories). Apply liquid matrix in sufficient quantity to thoroughly saturate the basin to settle the Mixture, and to eliminate voids and air pockets. Should any portions of the root mass be exposed, add additional Mixture as needed to thoroughly cover the root mass.
- 5. Mulching: Apply mulch in watering basins as indicated on the Contract Drawings. Refer to Section 32 94 00 – Landscape Planting Accessories for type and requirements.
- 6. Wrapping:
 - a. Inspect trees for injury to trunks, evidence of insect infestation, and improper pruning before wrapping.
 - b. Wrap trunks of all trees as directed spirally from bottom to top with specified tree wrap and secure in place.
 - c. Overlap 1/2 the width of the tree wrap strip and cover the trunk from the ground to the height of the second branch.
 - d. Secure tree wrap in place with twine wound spirally downward in opposite direction, tied around the tree in at least 3 places in addition to the top and bottom.
- 7. Staking/guying:
 - a. Stake/guy all trees immediately after each tree planting.
 - b. Stake all trees and all multi-trunk trees.
 - c. Flag or color all cables.
 - d. All work shall be acceptable to the Landscape Architect.
- C. Container-Grown and Ball and Burlap Plant Material: Set Plant Material plumb and in the center of the excavated planting hole, with top of the root ball raised above adjacent finish grade as indicated. Set Plant Material in the proper spacing and/or alignment(s) as indicated on the Contract Documents, or as further directed at the Project Site by the Landscape Architect.

1. For plastic container stock (4" pot, 1-gallon, 5-gallon, 15-gallon, etc.), carefully remove the plant container prior to setting the plant in the excavated hole so as not to damage root ball. Tip container to horizontal position and shake carefully to remove Plant Material. Support root ball during installation to prevent cracking or shedding of soil.
2. Set the Plant Material stock on the specified setting layer of compacted native soil, with the top of root ball set one-inch (1") above the finished grade to allow for settlement of the Plant Material within the excavated planting hole. Provide the orientation of the Plant Material that is confirmed and accepted by the Landscape Architect. During the process of determining an acceptable orientation of the plant material, carefully handle the Plant Material by its container; avoid handling the Plant Material by its trunk.
 - a. Plant Material with a damaged root ball upon removal of the container, or if the root ball fails to thoroughly hold the soil as it is removed from the container, or if the plant is mishandled or damaged during planting operations, shall be rejected.
3. For Ball and Burlap stock, carefully set whole root ball of the Plant Material stock on the specified setting layer of compacted native soil, with the top of root ball set two-inch (2") above the finished grade to allow for settlement of the Plant Material within the excavated planting hole. Provide the orientation of the Plant Material that is confirmed and accepted by the Landscape Architect. During the process of determining an acceptable orientation, carefully handle the Plant Material by its basket; avoid handling the Plant Material by its trunk or branches. Once orientation is accepted, remove 1/3 of the wire basket so as not to damage the root ball or any part of the plant. Do not remove the bottom of the wire basket. Discard top 1/3, do not bend back or bury.
 - a. Plant Material with a damaged root ball upon placing/planting, or if the root ball fails to thoroughly hold the soil as it is planted, or if the plant is mishandled or damaged during planting operations, shall be rejected.
4. Prepare the Amended Planting Backfill Mixture: Amend each cubic yard (cu/yd) of native soil excavated from the planting hole by incorporating and thoroughly mixing/blending the following:
 - a. ¼ yard of Bulk Composted Organic Soil Amendment Material (per Section 32 91 13 – Soil Preparation).
 - b. ½ pound of Granular Soil Conditioning Material & Fertilizer (per Section 32 91 13– Soil Preparation).
 - c. Add Mycorrhizal Inoculum to the excavated native soil, (per Section 32 91 13 –Soil Preparation), per the Manufacturer's latest printed instructions.

- 1) Pending the results of the Agronomic Soil Fertility Report, the Amended Planting Backfill Mixture may be modified accordingly to include additional soil amendments or fertilizers (gypsum, iron, potash, etc.) or the ratios as indicated in the Mixture indicated above may be modified.
 - a) The cost of providing modifications to the Amended Planting Soil Backfill Mixture (as recommended through the Agronomic Soil Fertility Report and as directed by the Landscape Architect) shall be borne by the Contractor.
5. In areas where indicated on the Contract Drawings, install the Deep Watering Bubblers as part of the irrigation system.
6. Backfilling the excavated planting hole:
 - a. Place the Amended Planting Backfill Mixture around the root ball in the excavated planting hole. Place the Mixture in six-inch (6") lifts, tamping each lift accordingly to settle the Mixture and eliminate voids and air pockets. Foot tamp the backfill, as required.
 - b. Maintain the plant plumb while working the Mixture around the root ball. When the planting hole is approximately half-backfilled, water thoroughly before placing the remainder of the Mixture.
 - c. Add the Fertilizer Tablets and other amendments (per Section 32 91 13 – Soil Preparation) as required, at the prescribed application rates indicated herein this Article or if not indicated, per the Manufacturer's instructions.
 - d. Place the final layers of the Mixture, tamping accordingly, to the top of the root ball. Do not place the Mixture on top of the root ball.
 - e. Dish and tamp top of the Mixture to form a three-inch (3") deep watering basin centered on the Plant Material's trunk to the rim width of the planting hole. Do not cover the top of the root ball with the backfill mixture.
7. Mulching: Apply mulch in watering basins as indicated on the Contract Drawings. Refer to Section 32 94 00 – Landscape Planting Accessories for type and requirements.
8. Wrapping:
 - a. Inspect trees for injury to trunks, evidence of insect infestation, and improper pruning before wrapping.
 - b. Wrap trunks of all trees as directed spirally from bottom to top with specified tree wrap and secure in place.
 - c. Overlap 1/2 the width of the tree wrap strip and cover the trunk from the ground to the height of the second branch.

- d. Secure tree wrap in place with twine wound spirally downward in opposite direction, tied around the tree in at least 3 places in addition to the top and bottom.

9. Staking/guying:

- a. Stake/guy all trees immediately after each tree planting.
- b. Stake all trees and all multi-trunk trees.
- c. Flag or color all cables.
- d. All work shall be acceptable to the Landscape Architect.

D. Native Wildflower and Grass Seed Material: Drill or hand apply seed per volumes specified within the Construction Documents. Apply native grass and wildflower seed after ground preparation is complete between September 15 and October 15 or February 15 and March 15. Landscape Architect shall be consulted prior to seeding to review preparation and installation.

1. Seed as follow to ensure complete coverage as noted:

- a. Treat all seed areas with an aquatic approved herbicide when vegetation is present, two (2) prior to all seeding.
- b. Fine grade areas that receive seed eliminate low areas that may hold water.
- c. Provide 2 parts masonry sand to 1 part pure live seed (PLS). Granule Mycorrhizal shall also be included and may substitute the masonry sand.
- d. Herbicide reapplication shall be required prior to broadcasting seed if visible vegetation is present.
- e. Broadcast half the Native Grass and/or Wildflower Seeds evenly over the entire area prior to placement of compost at the rates indicated within the Construction Documents. Sow remaining seed in a perpendicular direction to the initial sowing prior to placement of compost.
- f. Placement of one-half inch (1/2") organic compost by Landscape Contractor
- g. Wildflower seed to be broadcast similar to the above and seed shall be allows to rest on top of the compost without pressing into the substrate. Do not cover the seed more than 1/16".
- h. Cover seed with a 100% wood fiber hydroseeding mulch.

2. Jute netting or Biodegradable Erosion Control Blanket:

- a. Install per plans and/or all areas that exceed 3:1 slopes using biodegradable stakes.

3.04 PRUNING AND THINNING OF PLANT MATERIAL

A. Pruning/Thinning of Tree Canopy

1. At no time shall Plant Material be pruned, trimmed, thinned, shaped, or topped prior to delivery. Pruning, trimming, thinning, shaping, or topping of Plant Material shall be only conducted on the Project Site, and under the presence and direction of the Landscape Architect or approved Certified Arborist. Plant Material that has been pruned and delivered to the Project Site without prior approval by the Landscape Architect or an approved Certified Arborist will be rejected.

B. When directed by the Landscape Architect or an approved Certified Arborist, Contractor shall prune, thin, and shape plant material, according to standard horticultural practice, to preserve the natural character of the Plant Material.

1. Pruning and remedial work shall be done per ANSI A300.
2. Prune trees to retain required height and spread. Do not cut tree leaders; remove only injured or dead branches from trees.
3. Prune shrubs accordingly to retain natural character.
4. Provide pruning, cabling and bracing, irrigation, pest and disease control and other remedial treatments as recommended to assure the long-term health of the trees and existing vegetation, and the safety of persons and property.
5. Newly planted trees shall be pruned near the termination of the Landscape Establishment Period, per the direction of the Landscape Architect, as required.

3.05 CLEAN UP AND PROTECTION

- A. During installation operations, keep Work area in an orderly and safe condition. Contractor shall remove trash caused from his Work on a weekly basis throughout the duration of the Work.
- B. Protect landscaping from damage due to landscape operations, operations by other Contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.
- C. Upon completion of his Work under this Section, the Contractor shall remove rubbish, waste, debris, excess construction materials, surplus soil and other items resulting from construction operations and legally dispose of it off the Owner's property.
- D. Scars, ruts, or other marks in the ground caused by the Contractor's Work shall be repaired.
- E. Remove equipment and implements of service and leave the entire Project Site area in a neat, clean, and Owner-approved condition.
- F. Labels: Remove all nursery-type labels, flags, and or identification markings from Plant Materials AS DIRECTED BY THE Landscape Architect.

3.06 MAINTENANCE

- A. Maintain the trees, shrubs, groundcovers, perennials, native grasses until Final Completion of the entire project. Upon Final Completion, the Owner will assume maintenance as recommended by the written maintenance instructions submitted by the Landscape Contractor for Sodded areas only.
- B. Maintenance shall include pruning, cultivating, weeding, watering, and application of appropriate insecticides and fungicides necessary to maintain plants free of insects and disease.

1. Re-set settled plants to proper grade and position. Restore planting saucer and adjacent material and remove dead material.
2. Tighten and repair guy wires and stakes as required.
3. Correct defective work as soon as possible after deficiencies become apparent and weather and season permit.
4. Deep-water trees, plants, groundcover, perennial and native grass beds within the first 24 hours of initial planting, and thereafter as required for healthy growth until final acceptance.

3.07 SUBSTANTIAL COMPLETION

- A. An inspection of the trees, shrubs, groundcovers, perennials and native grasses will be made by the Landscape Architect upon request for Application of Substantial Completion by the Landscape Contractor. Provide notification of at least five (5) working days before requested inspection date.

3.08 FINAL COMPLETION

- A. An inspection of the trees, shrubs and ground covers will be made by the Landscape Architect upon request for Final Completion by the Landscape Contractor.

END OF SECTION 329300

SECTION 33 05 13 SEWER MANHOLES, FRAMES, AND COVERS

PART 1 - GENERAL

1.1 SUMMARY

1.2 Section Includes

1. Monolithic concrete, modular precast concrete, masonry, and precast polyethylene manhole assemblies.

1.3 Related Sections

1. Section 31 23 16 - Excavation
2. Section 33 31 11 - Sanitary Sewage Systems
3. Section 33 40 00 - Storm Drainage Utilities

1.4 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.
- B. ASTM International (ASTM)
 1. ASTM A48 - Gray Iron Castings.
 2. ASTM C55 - Concrete Building Brick.
 3. ASTM C478 - Precast Reinforced Concrete Manhole Sections.
 4. ASTM C923 - Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.
 5. ASTM D1248 - Polyethylene Plastics Molding and Extrusion Materials.
 6. ASTM D2412 - Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- C. International Masonry Industry All-Weather Council (IMIAC)
 1. Recommended Practices and Guide Specification for Cold Weather Masonry Construction.
- D. Missouri Standard Specifications for Highway Construction, latest edition.
- E. Missouri Standard Plans for Highway Construction, latest edition.

1.5 SUBMITTALS

- A. Shop Drawings: Indicate reference to Construction Drawings of manhole locations, elevations, piping with sizes, locations, and elevations of penetrations.

PART 2 - PRODUCTS

2.1 MANHOLES

- A. Cast-In-Place Concrete: Nonreinforced cast in place concrete barrel.
 1. Concrete: 3500 psi concrete conforming to Section 03300.
 2. Forms: Steel sheet accurately shaped and fabricated of sufficient strength to form dense watertight walls to true dimensions.
- B. Precast Concrete: Reinforced precast concrete barrel.
 1. Manhole sections conforming to ASTM C478 with gaskets in accordance with ASTM C923 or Section 1033 of the Missouri Standard Specifications for Highway Construction, latest Edition.
 2. Construct manholes of precast concrete sections as required by Construction Drawings to size, shape, and depth indicated.

- C. Concrete Brick: ASTM C55, Grade N Type I-moisture controlled, normal weight, of same grade, type and weight as block units, nominal modular size of 3 5/8-inches x 7 5/8-inches x 2 1/4-inches.
- D. Precast Polyethylene:
 - 1. Manufacturer: Advanced Drainage Systems (ADS) or approved equal.
 - 2. Precast polyethylene in accordance with ASTM D1248. Nominal cylinder internal diameter shall be 48-inches and shall be designed to accept concrete filled polyethylene manhole lids and standard cast iron frames with lid or grate.
 - 3. Manholes shall have compressive strength that meets ASTM D2412 standards.
- E. Mortar and Grout: Mortar for finishing and sealing shall be Class "C". Honeycombing less than 2-inches deep shall be repaired using Class "D" mortar.
- F. Brick Transition Reinforcement: Formed steel 8-gauge wire with galvanized finish.
- G. Configuration:
 - 1. Barrel Construction: Concentric with eccentric cone top section.
 - 2. Shape: Cylindrical.
 - 3. Clear Inside Dimensions: 48-inches diameter minimum or as indicated on Construction Drawings.
 - 4. Design Depth: As indicated on Construction Drawings.
 - 5. Clear Lid Opening: 22-inches minimum.
 - 6. Pipe Entry: Provide openings as indicated on Construction Drawings.
 - 7. Main and Lateral Pipes: Neatly cut off main and lateral pipes flush with inside of manhole or inlet where they enter structure walls. Point up irregularities and rough edges with nonshrinking grout.
- H. Inverts: Shape inverts for smooth flow across structure floor as indicated on Construction Drawings. Use concrete and mortar to obtain proper grade and contour. Finish surface with fine textured wood float.

2.2 COMPONENTS

- A. Lid and Frame:
 - 1. Manufacturer: Neenah Foundry Company, East Jordan Iron Works, or approved equal.
 - 2. ASTM A48, Class 30B heavy duty cast iron construction, machined flat bearing surface.
 - 3. Removable lid, closed or open as indicated on Construction Drawings, sealing gasket.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify items specified by other Sections are properly sized and located.
- B. Verify that built-in items are in proper location and ready for roughing into work.
- C. Verify that the excavation for manholes is correct.

3.2 PREPARATION

- A. Coordinate placement of inlet and outlet pipe or duct sleeves as indicated on Construction Drawings.

3.3 PRECAST MANHOLE CONSTRUCTION

- A. Place base pad to proper elevation and location and trowel top surface level for placement of manhole barrel.
- B. Place manhole barrel plumb and level to correct elevations and anchor to base pad.

1. After completion of slab foundation, lower first joint of manhole barrel into position, grooved end first, and set level and plumb on concrete base. Align and adjust to proper grade prior to placing and forming invert. Pour invert immediately after setting of first section of manhole barrel.
 2. Prior to setting subsequent manhole barrel sections, apply primer to tongue and groove ends and allow to set in accordance with manufacturer's recommendations. Place "Ram-nek", or equivalent, plastic rope on tongue end. Lower next section into position, and remove excess material from interior of structure. Add additional material on exterior of joint, if necessary, for completely water-tight joint.
- C. Set cover frames and lids level without tipping, to correct elevations. Utilize pre-cast rings or brick and mortar to achieve final rim elevation. Maximum limit, 4 courses.

3.4 CAST-IN-PLACE MANHOLE CONSTRUCTION

- A. Cast-in-place concrete shall conform to the applicable requirements of concrete in Division 3. Utilize steel forms.
- B. Place base pad to proper elevation and location and pour monolithically with invert. Base shall support pipe to first joint.
- C. Deposit concrete in evenly distributed layers of about 18 inches, with each layer vibrated to bond to preceding layer.
- D. Place gasket between all joints and paint exterior of manhole within 5' of the joint with mastic waterproofing.
- E. Place precast concrete cone.
- F. Set section cover frames and lids level without tipping, to correct elevations. Utilize pre-cast rings or brick and mortar to achieve final rim elevation. Maximum limit, 4 courses.

3.5 MASONRY MANHOLE CONSTRUCTION

- A. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- B. Lay masonry units in running bond. Course 3 brick units and 3 mortar joints to equal 8 inches.
- C. Form flush mortar joints
- D. Lay masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- E. Install joint reinforcement 16 inches on center
- F. Place joint reinforcement in first and second horizontal joints above base pad and below lid frame opening
- G. As work progresses, build in fabricated metal items
- H. Cut and fit masonry for pipes as specified herein
- I. Set cover frames and covers level to correct elevations without tipping.

END OF DOCUMENT 33 51 11

Section 33 10 00 – Water Utilities

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. On-site private facilities and public facilities to be owned by the Owner, including water piping, fittings, domestic potable waterline and fire protection system supply waterline, valves, and fire hydrants.
- B. Related Sections
 - 1. Section 31 23 16 – Excavation
 - 2. Section 31 25 00 – Erosion & Sedimentation Control

1.2 REFERENCES

- A. American Society of Mechanical Engineers (ASME)
 - 1. ASME B 16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
- B. ASTM International (ASTM)
 - 1. ASTM B88 - Seamless Copper Water Tube
 - 2. ASTM D1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
 - 3. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series)
 - 4. ASTM D2564 - Poly (Vinyl Chloride) (PVC) Solvent Cement
 - 5. ASTM D2672 - Poly (Vinyl Chloride) (PVC) Integrally Molded Bell Ends For Solvent - Cemented Pipe Joints.
 - 6. ASTM D3139 - Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals
 - 7. ASTM F477 - Elastomeric Gaskets And Lubricant
 - 8. ASTM F656 - Poly (Vinyl Chloride) (PVC) Cement Primer
- C. American Water Works Association (AWWA)
 - 1. AWWA C104 – Cement-Mortar Lining For Ductile-Iron Pipe And Fittings For Water
 - 2. AWWA C105 – Polyethylene Encasement for Ductile Iron Piping for Water and other Liquids
 - 3. AWWA C116 – Protective Fusion-Bonded Epoxy Coatings For The Interior And Exterior Surfaces Of Ductile-Iron And Gray-Iron Fittings For Watersupply Service
 - 4. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
 - 5. AWWA C153 - Ductile-Iron Compact Fittings For Water Service
 - 6. AWWA C500 - Gate Valves for Water and Sewage Systems
 - 7. AWWA C550 - Protective Interior Coatings For Valves And Hydrants
 - 8. AWWA C504 - Rubber-Seated Butterfly Valves
 - 9. AWWA C600 - Installation of Ductile-Iron Water Mains and Appurtenances
 - 10. AWWA C605 - Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings For Water
 - 11. AWWA C651 - Disinfecting Water Mains
 - 12. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water Distribution
- D. National Fire Protection Associations (NFPA)
 - 1. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances
- E. Missouri Department of Natural Resources – 10 CS 60-10.010

1.3 QUALITY ASSURANCE

- A. Products, where marked for compliance with code or test standards, shall also mark specific standard as required in the Contract Documents.
- B. Perform installation in accordance with utility company or municipality requirements.
- C. Valves: Mark manufacturer's name and pressure rating on valve body.
- D. Perform disinfection of potable lines in accordance with AWWA C651.

1.4 SUBMITTALS

- A. Product Data: Provide Project Engineer with data on pipe materials, pipe fittings, hydrants, valves, and accessories.
- B. Manufacturer's Certificate: Certify that products meet or exceed state or local requirements.
- C. Furnish 1 copy of results of meter test and hydrostatic pressure test to Owner and utility company upon completion of water distribution backfilling operations.
- D. Project Record Documents:
 - 1. Disinfection report: Record the following:
 - a. Type and form of disinfectant used.
 - b. Date and time disinfectant injection start and time of completion.
 - c. Test locations.
 - d. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
 - e. Date and time of flushing start and completion.
 - f. Disinfectant residual after flushing in ppm for each outlet tested.
 - 2. Bacteriological report: Record the following:
 - a. Date issued, project name, testing laboratory name, address, and telephone number.
 - b. Time and date of water sample collection.
 - c. Name of person collecting samples.
 - d. Test locations
 - e. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
 - f. Coliform bacteria test results for each outlet tested.
 - g. Certification that water conforms, or fails to conform, to bacterial standards.
 - h. Bacteriologist's signature and authority.
 - 3. Accurately record actual locations of piping mains, valves, connections, and top of pipe elevations.
 - 4. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

PART 2 – PRODUCTS

2.1 PIPE

- A. Pipe sizes up to and including 3 inches that are installed below grade and outside building shall comply with the following:
 - 1. Continuous HDPE pressure pipe meeting ASTM 2737: Pipe, AWWA C901, rated SDR 9 150).
 - a. Pipe shall be ADS PolyFlex Potable Water Service Tubing (CTS) conforming to the minimum requirements of cell classification 445474E as defined in ASTM D3350.
- B. Pipe sizes 4 to 16 inches that are installed below grade and outside building shall comply with one or combination of following:
 - 1. Ductile Iron Water Pipe: AWWA C151, Pressure class 350 (4-12") Pressure Class 250 (14-16").
 - a. Fittings: Either mechanical joint or push-on-joint, AWWA C153, and shall be coated with a 6-8 mil nominal thickness fusion bonded epoxy conforming to the requirements of AWWA C550 and C116, or cement mortar lined in accordance with AWWA C104.
 - b. Elastomeric gaskets and lubricant: ASTM F477.
 - 2. Polyvinyl Chloride (PVC) Water Pipe: Pipe, AWWA C900, rated DR 18 (Class 150), continually marked as required.
 - a. Elastomeric gaskets and lubricant: ASTM F477 for smaller pipes.
 - b. Pipe joints: Integrally molded bell ends, ASTM D3139.

2.2 VALVES

- A. Gate Valves, 2-Inches and Larger:
 - 1. Manufacturer and Model: Mueller Resilient Wedge Gate Valves or approved equal.
 - 2. AWWA C500, Iron body, non-rising stem with square nut, single wedge, resilient seat, flanged or mechanical joint ends, control rod, post indicator where indicated on Construction Drawings, extension box and valve key.
- B. Ball Valves, 2-Inches and Smaller:
 - 1. Manufacturer and Model: Mueller Oriseal or approved equal.
 - 2. Brass body, teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA compression inlet end, compression outlet with electrical ground connector, with control rod, extension box and valve key.
- C. Butterfly Valves, From 2-Inch to 24-Inch: AWWA C504, Iron body, bronze disc, resilient replaceable seat, water or lug ends, infinite position lever handle.
- D. Check Valves, Post Indicator Valves, and Backflow Preventors
 - 1. Refer to Section 13900 - Fire Suppression in Architectural/Building Specifications

2.3 FIRE HYDRANTS

- A. Fire Hydrants: Type as required by utility company/Local Fire Department and as shown on Construction Drawings.
- B. Hydrant Extensions: Fabricate in multiples of 6-inches with rod and coupling to increase barrel length.
- C. Hose and Steamer Connections: Match sizes with utility company, with two hose nozzles, one pumper nozzle.
- D. Finish: Apply primer and 2 coats of enamel or special coating to color as required by utility company.

2.4 ACCESSORIES

- A. Thrust Blocking: Place 3000 psi concrete to provide sufficient bearing area to transmit unbalanced thrust from bends, tees, caps, or plugs to undisturbed soil without loading undisturbed soil in excess of 2,500 pounds per square foot when water main pressure is 100 psi.

MINIMUM THRUST BLOCKING BEARING AREAS

Pipe Diameter	Tees Sq. Ft	90° Bend Sq. Ft	45° Bend Sq. Ft	22½° Bend Sq. Ft.	11¼° Bend Sq. Ft.	5 5/8 Sq. Ft.	BendCap/Plug Sq. Ft.
3"	1.0	1.0	1.0	1.0	1.0	1.0	1.5
4"	1.0	1.0	1.0	1.0	1.0	1.0	2.0
6"	1.5	2.0	1.0	1.0	1.0	1.0	3.0
8"	2.5	3.5	1.8	1.0	1.0	1.0	4.0
10"	4.0	5.5	2.8	1.5	1.0	1.0	6.0
12"	6.0	8.0	4.0	2.0	1.5	1.0	8.5
14"	8.0	11.0	5.5	3.0	2.0	1.5	12.0
16"	10.0	14.2	7.0	4.0	3.0	2.5	15.0
18"	21.0	21.0	12.0	6.0	4.0	3.5	24.0

- B. Locked mechanical joint fittings shall be installed where vertical changes in direction are required and, if approved by Owner and governing authority, can be installed in lieu of above thrust blocking requirements.
- C. Polyethylene Encasement: Single layer of two ply cross-laminated high density polyethylene encasement per AWWA C105, Section 4.1.2, Type III, Class C (Black), Grade 33, tensile strength 5,000 psi minimum, elongation 100 percent, thickness nominal 0.004 inch (4 mil).
- D. Trace Wire: Magnetic detectable conductor, (#12 Copper) brightly colored plastic covering imprinted with "Water Service" in large letters.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that building service connection and municipal utility water main size, location, and depth are as indicated on Construction Drawings.

3.2 PREPARATION

- A. Ream pipe and tube ends and remove burrs.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare pipe for connections to equipment with flanges or unions.

- D. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.

3.3 TRENCHING AND BEDDING

- A. Excavate pipe trench and place bedding material in accordance with Section 31 23 23.

3.4 INSTALLATION - PIPE AND FITTINGS

- A. Maintain separation of water main from sanitary and storm sewer piping in accordance with state or local codes.
- B. Install ductile iron pipe and fittings in accordance with AWWA C600.
- C. Install PVC pipe and fittings in accordance with AWWA C605.
- D. Ductile iron pipe and fittings shall be installed with polyethylene encasement around the pipe for the entire length of the project except where water main is within steel casing or is concrete encased. Install polyethylene encasement in accordance with AWWA C105, Method A.
- E. Install pipe to allow for expansion and contraction without stressing pipe or joints or as specified by pipe manufacturer.
- F. Install access fittings in accordance with local codes to permit disinfection of water system performed under this Section.
- G. Connections with Existing Pipelines: Where connections are made between new work and existing piping, make connection using suitable fittings for conditions encountered. Make each connection with existing pipe at time and under conditions with least interference with operation of existing pipeline and in compliance with local utility company.
- H. Form and place concrete for thrust blocks or other specified methods of retainage at each change of direction or end of pipe main.
- I. Place pipe to depth in accordance with Section 31 23 16 and the details in the plans.
- J. Backfill trench in accordance with Section 31 23 23 and the details in the plans.
- K. Install trace wire continuous over top of non-metal pipe. Bury a minimum of 6 inches below finish grade, and above pipeline.

3.5 INSTALLATION - VALVES AND HYDRANTS

- A. Install gate valves as indicated on Construction Drawings. Support valve on concrete pads with valve stem vertical and plumb. Install valve boxes in manner that will not transmit loads, stress, or shock to valve body. Center valve box over operating nut of valve vertical and plumb. Securely fit valve box together leaving cover flush with finished surface.
- B. Install fire hydrant assemblies as indicated on Construction Drawings in vertical and plumb position with steamer/pumper nozzle pointed perpendicular to traffic where hydrant is adjacent to street, roadway, or parking lot drive or toward protected building unless otherwise directed by local authorities. Support hydrant assembly on concrete pad and firmly brace on side opposite inlet pipe against undisturbed soil and concrete blocking. Place minimum of 6-cubic feet of crushed stone or gravel around hydrant base and barrel after thrust blocking has cured at least 24 hours. Maintain vertical position of hydrant backfilling and compacting.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Disinfect distribution system with chlorine before acceptance for domestic operation. Chlorine dosage shall be not less than 50 parts per million. Flush lines before introduction of chlorinating materials and after contact period of not less than 24 hours. Flush with clean water after contact period until residual chlorine content is not greater than 1.0 part per million. Flush water discharged from water supply lines or hydrants shall not be allowed to discharge directly onto exposed soil or turf which could result in erosion of soil. If potential for erosion exists at discharge point, measures shall be taken to prevent erosion. Open and close valves in lines being disinfected several times during contact period. After disinfection, take water sample and bacteriological test in accordance with AWWA C651. Satisfactory disinfection shall be demonstrated in accordance with the requirements of the Missouri Department of Natural Resources and the City of Buffalo, MO. Do not place distribution system in service until approval is obtained from local governing authorities.
- B. Contractor shall provide a means of neutralizing the super-chlorinated water before releasing into the environment. This may be accomplished by either a method of dechlorination, direct release into a detention area approved by Owner, or any method acceptable to federal, state, and local codes. Direct release to open ground shall not be allowed, unless contained within an on site detention facility with 6" permanent storage. In this case, the Contractor shall time the release to assure that no rainstorms are imminent. The intent of this condition is to allow the majority of the chlorine to evaporate into the atmosphere before a rainstorm has the opportunity to wash the residual downstream. Contractor shall not release super-chlorinated water directly into the sanitary sewer system, private or public, nor any storm drain system not directly discharging into the detention facility.

3.7 SERVICE CONNECTIONS

- A. Provide water service connection in compliance with utility company requirements including reduced pressure backflow preventer (if required) and water meter with by-pass valves and sand strainer.

3.8 FIELD QUALITY CONTROL

- A. Test water distribution system pipe installed below grade and outside building in accordance with the following procedures:
 - 1. Perform testing of pipe materials, joints, and other materials incorporated into construction of water mains and force mains to determine leakage and water tightness. Test pressure pipeline in accordance with Section 4 of AWWA C600 and NFPA 24. In the event state or local code requires more stringent test, more stringent test shall take precedence.
 - 2. Pressure Test: After pipe has been laid, subject newly laid pipe or valved section to hydrostatic pressure of at least 1.5 times working pressure at point of testing and not less than 1.25 times working pressure at highest point along test section.

3. Leakage Test: Conduct leakage test concurrently with pressure test. Leakage is defined as quantity of water that must be supplied into newly laid pipeline or valved section thereof to maintain pressure within 5 psi of specified test pressure after air in pipeline has been expelled and pipeline has been filled with water. Leakage shall not be measured by drop in pressure in test section over period of time.
 - a. Leakage test for ductile iron pipe shall not be greater than that determined by the following formula:
$$L = \frac{SD\sqrt{P}}{133,200}$$

Where: L = allowable leakage, (gallons per hour)
S = length of pipe tested, (feet)
D = nominal diameter of pipe, (inches)
P = average test pressure during test, (psig)
 - b. Leakage test for PVC pipe shall be in accordance with AWWA Standard C605.
4. Visible Leakage: Repair visible leaks regardless of amount of leakage measured.
5. Acceptance of Installation: If test of pipe laid in place discloses leakage greater than that specified, Contractor shall, at his own expense, locate leak and make repairs as necessary until leakage is within specified allowance. Supply water for testing at no expense to Owner.

END OF SECTION 33 10 00

SECTION 33 31 11 - SANITARY SEWAGE SYSTEMS

GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Sanitary sewer drainage piping, fittings, accessories, cleanouts, and bedding.
 - 2. Connection of site sanitary sewer system to municipal sanitary sewer systems.
- B. Related Sections
 - 1. Section 31 23 16 – Excavation
 - 2. Section 33 05 13 - Sewer Manholes, Frames, and Covers
 - 3. Section 03 30 00 – Cast-in-Place Concrete

1.2 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.
- B. ASTM International (ASTM)
 - 1. ASTM A74 - Cast Iron Soil Pipe and Fittings
 - 2. ASTM A746 - Ductile Iron Gravity Sewer Pipe
 - 3. ASTM C425 - Compression Joints for Vitrified Clay Pipe and Fittings
 - 4. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings
 - 5. ASTM C700 - Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
 - 6. ASTM D2241 - Poly (vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
 - 7. ASTM D2657 - Heat-Joining Polyolefin pipe and Fittings
 - 8. ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
 - 9. ASTM D3035 - Polyethylene (PE) Plastic Pipe Using Flexible Elastomeric Seals
 - 10. ASTM D3139 - Joints for Plastic Pressure Pipe Using Flexible Elastomeric Seals
 - 11. ASTM D3261 - Butt Heat Fusion Polyethylene (PE) Plastic Fittings For Polyethylene Plastic Pipe And Tubing
 - 12. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe
 - 13. ASTM F1417- Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.
- C. American Water Works Association (AWWA)
 - 1. AWWA C111 - Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings
 - 2. AWWA C600 - Ductile-Iron Water Mains And Their Appurtenances
 - 3. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In, For Water Distribution
 - 4. AWWA C901 - Polyethylene (PE) Pressure Pipe, Tubing And Fittings 1/2 Inch Through 3 Inches, For Water Distribution
 - 5. AWWA C906 - Polyethylene (PE) Pressure Pipe And Fittings, 4 Inch Through 63 Inch, For Water Distribution

1.3 SUBMITTALS

- A. Project Record Documents:
 - 1. Accurately record actual locations of pipe runs, connections, cleanouts, and invert elevations.
 - 2. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

1.4 PROJECT CONDITIONS

- A. Coordinate work with termination of sanitary sewer connection outside building and connection to municipal sewer utility service.

PRODUCTS

1.5 SEWER PIPE, FITTINGS, AND JOINTS

- A. Polyvinyl Chloride Pipe (PVC): ASTM D 3034, rated SDR 26 unless otherwise specified by the utility company. Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 3034 classification.
 - 1. Pipe joints: Integrally molded bell ends, ASTM D 3034, Table 2, with factory supplied elastomeric gaskets and lubricant.

1.6 PIPE ACCESSORIES

- A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene-ribbed gasket for positive seal.
- B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps, etc.

1.7 CLEANOUTS AND MANHOLES

- A. Manholes shall conform to Section 02536.
- B. Lid and Frame: Provide in accordance with Section 02536. Provide traffic grade and rated covers and frames where cleanouts and manholes are within pavement, with the letters "SSCO" or "SANITARY SEWER" respectively cast into the cover.
- C. Shaft Construction: Cast iron shaft of internal diameter as specified on Construction Drawings with 2500 psi concrete collar for cleanouts.

1.8 APPURTENANCES

- A. Trace Wire: Magnetic detectable conductor (#12 copper), brightly colored plastic covering, imprinted with "Sanitary Sewer Service" in large letters.

EXECUTION

1.9 EXAMINATION

- A. Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Construction Drawings.

1.10 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with bedding material.
- B. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.

1.11 BEDDING

- A. Excavate trench and place bedding material in accordance with Section 02300.

1.12 INSTALLATION - PIPE

- A. Install type and class of pipe as shown on the drawings. Pipes shall be laid and maintained to the required line and grade with necessary fittings, bends, manhole risers, cleanouts and other appurtenances placed at the required locations. The pipe shall be installed with uniform bearing under the full length of the barrel of the pipe. The pipe shall be inspected for defects and cracks before being lowered into the trench. De-

fective, damaged or unsound pipe, or pipe that has had its grade disturbed after laying shall be taken up and replaced. Commence installation at lowest point with the bell end upgrade.

- B. No pipe shall be laid in water or when trench conditions are unsuitable for work.
- C. Pipe connecting to manholes or other structures shall terminate flush inside of the structure wall.
- D. Joints for PVC and CISP shall be thoroughly lubricated with an approved lubricant before pipe sections are slipped together. Open ends shall be fully protected with a stopper to prevent earth or other material from entering the pipe during construction. Carefully free interior of the pipe from dirt, cement and other deleterious material as the work progresses.
- E. Maintain separation of potable water main from sewer piping at crossings a minimum of 10 feet horizontal and 18 inches vertical.
- F. Install HDPE piping and fittings to AWWA C901 and C906. Butt fusion welded per ASTM D3261.
- G. Route pipe in straight line parallel to roads, buildings and adjacent utilities and as shown on the drawings.
- H. Establish elevations of buried piping with sufficient cover as recommended by pipe manufacturer to ensure not less than 3 feet of cover, except as noted on drawings.
- I. Form and place concrete for thrust blocks at each elbow of pipe force main. See construction drawing for details of construction.
- J. Backfill trench in accordance with Section 02300.
- K. Install trace wire continuous over top of non-metal pipe. Bury 6 inches minimum below finish grade, above pipeline.

1.13 INSTALLATION – CLEANOUTS AND MANHOLES

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. For cleanouts, form and place cast-in-place concrete base pad with provision for sanitary sewer pipe to be installed to proper elevations.
- C. For manholes, construct inverts according to the following guidelines:
 - 1. Invert channel shall be smooth and accurately shaped to a semicircular bottom to match with the inside of the adjacent sewer section.
 - 2. Invert channels and structure bottoms shall be shaped with mortar and lean concrete.
 - 3. Changes in size and grade of invert shall be made gradually and evenly.
 - 4. Changes in the direction of the sewer entering branch or branches shall have a true curve of as large a radius as the manhole will permit.
- D. For manholes, provide manhole rings, frame, and cover as shown on the construction drawings.

1.14 FIELD QUALITY CONTROL

- A. Field quality control shall be conducted by the Contractor in accordance with Section 01452.
- B. Pipes and joints shall not be completely backfilled until after inspection, testing, and approval by the Owner and local jurisdiction.
- C. Prior to testing for leakage, the pipe trench shall be backfilled to at least the spring line of the pipe. If required to prevent pipe movement during testing, additional backfill shall be added leaving the pipe joints uncovered to permit inspection.
- D. Leakage testing of all manholes shall be in accordance with ASTM C1244-93 or C969-94.

- E. Exfiltration Test
 - 1. Each section of sewer line between successive manholes shall be tested by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole, using stoppers.
 - 2. Fill the manhole and pipe with water to a point which produces a maximum of 3 feet of head above the invert of the sewer at the center of the upper manhole; or if groundwater is present, 3 feet of head above the average adjacent groundwater level.
 - 3. The allowable leakage shall be 200 gal/inch of pipe diameter/mile/day
- F. Infiltration Test
 - 1. If excessive ground water is encountered in the construction of a section of the sewer, the exfiltration test shall not be used.
 - 2. The upper and lower ends of the sewer to be tested shall be closed sufficiently to prevent the entrance of water.
 - 3. Pumping of ground water shall be discontinued for at least 3 days; then infiltration shall be tested.
 - 4. Infiltration into each section of sewer between adjoining manholes shall not exceed that allowed for the exfiltration test, except that head conditions shall be a maximum of 6 feet.
 - 5. The allowable leakage shall be 200 gal/inch of pipe diameter/mile/day.
- G. The Exfiltration Test may be limited to the manholes only when the authority having jurisdiction does not require the test and the construction manager waives the test. The Infiltration Test will always be required when excessive ground water is encountered in addition to the air test.
- H. Air Test: Gravity systems shall be air tested between manholes at 3.5 psi for 5 minutes per ASTM F1417 for plastic pipes.
- I. Deflection Test:
 - 1. Deflection tests shall be conducted on all plastic pipe using a mandrel with a diameter equal to 95 percent of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices.
 - 2. Allowable Deflection: Maximum allowable pipe deflection shall not exceed 5 percent of nominal inside diameter.
 - 3. Mandrel: Mandrel, go/no-go, device shall be cylindrical in shape and constructed with either 9 or 16 evenly spaced arms or prongs. Mandrels with fewer arms will be rejected as not sufficiently accurate. Contact length of mandrel's arms shall equal or exceed nominal inside diameter of sewer to be inspected. Critical mandrel dimensions shall carry tolerance of 0.01-inch maximum. Contractor shall provide mandrel and necessary equipment for mandrel test.
 - 4. Procedure: Mandrel shall be hand-pulled through flexible pipe sewer lines no earlier than 30 days after trench has been completely backfilled. Sections of sewer not passing mandrel shall be uncovered and rebedded, rerounded, or replaced to satisfaction of Owner or governing agency. Repaired section shall be retested.
- J. Provide measuring devices, meters, water, materials, and labor for making the required tests.
- K. Tests shall be conducted in the presence of the Construction Manager or his designee. Test data shall be submitted to the Engineer for review and approval.

END OF DOCUMENT 33 31 11

SECTION 33 40 00 – STORM DRAINAGE UTILITIES

PART 1 – GENERAL

1.1 WORK INCLUDES

- A. Storm sewer system including pipes and bedding material indicated on drawings.
- B. Fittings and accessories to complete the drainage system.

1.2 RELATED WORK

- A. Specified elsewhere:
 - 1. Section 31 23 16 – Excavation
 - 2. Section 31 23 23 – Fill
 - 3. Section 31 25 00 – Erosion & Sedimentation Control
 - 4. Section 33 49 00 – Storm Drainage Structures

1.3 REFERENCES. Specified references, or cited portions thereof, current at date of bidding documents unless otherwise noted, govern the work.

- A. Missouri Department of Transportation (MoDOT): Standard Specifications for Highway, including all addenda.

1.4 REGULATORY REQUIREMENTS

- A. Conform to the applicable portions of Section 203, 1026 and 1041 of the Missouri Department of Transportation (MoDOT): Standard Specifications for Highway, including all Supplemental Specifications and Recurring Special Provisions.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Transport, deliver, unload, store and handle all pipe and fittings to prevent damage to materials or work.
- B. All damaged, broken or otherwise defective materials will be rejected.
- C. Store all circular gaskets and special lubricants in packaged materials with manufacturer's name, brand and all other specific data plainly marked thereon.

1.6 SUBMITTALS

- A. Accurately record actual locations of pipe runs, connections, manholes, inlets and invert elevations.
- B. Submit product data for approval.

PART 2 – PRODUCTS

2.1 STORM SEWERS

- A. HP Storm Pipe Dual Wall PP Pipe (High-performance Polyethylene Pipe) for gravity-flow storm drainage conforming to ASTM F2736 with smooth interior.
- B. Reinforced Concrete Pipe (RCP) conforming to Section 1026 of the MoDOT Standard Specifications for the size, class & type of sewer shown on the plans.

2.2 JOINT MATERIAL

- A. HP Pipe:
 - 1. Joints shall be water tight conforming to ASTM D3212. The spigot joint shall have two gaskets meeting the requirements of ASTM F477.
- B. RCP Pipe:
 - 1. Preformed Flexible Gaskets – Conforming to Section 733 of the MoDOT Standard Specifications.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Site Inspection: Inspect site and verify all grades, levels and conditions are as indicated on the layout drawings.
- B. Inspect all areas and conditions where drainage structures are to be installed.
 - 1. Inspect field conditions before ordering materials.
 - 2. Notify Engineer in writing of conditions detrimental to proper and timely completion of work.
 - 3. Do not proceed with work until unsatisfactory conditions are corrected.

3.2 COORDINATION

- A. Schedule work and notify all crafts in time so provisions for their work can be made without delaying project progress.
- B. All installations conform to lines and grades shown on drawings.
 - 1. Place structures where indicated on drawings unless their location is changed by the Engineer.
 - 2. Field conditions dictate deviation from drawings, no change made without written authorization of the Engineer.

3.3 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with fine aggregate.
- B. Remove large stones or other hard matter that could damage piping or impede consistent backfilling or compaction.

3.4 BEDDING

- A. Excavate pipe trench in accordance with Section 203 of MoDOT's Standard Specifications for work of this section.
- B. Place bedding material at trench bottom, level materials in a continuous layer.

3.5 INSTALLATION OF STORM SEWERAGE SYSTEM

- A. Storm Sewer Lines: Install pipe, fittings and accessories in accordance with MoDOT's Standard Specifications.

3.6 HORIZONTAL SEPARATION – WATER MAINS AND SEWERS

- A. Water mains shall be located at least ten feet horizontally from any existing or proposed drain, storm sewer, sanitary sewer, combined sewer or sewer service connection.
- B. Water mains may be located closer than ten feet to a sewer line when:
 - 1. Local conditions prevent a lateral separation of ten feet; and
 - 2. The water main invert is at least 18 inches above the crown of the sewer; and
 - 3. The water main is either in a separate trench or in the same trench on an undisturbed earth shelf located to one side of the sewer.
- C. When it is impossible to meet (1) or (2) above, both the water main and drain or sewer shall be constructed of slip-on mechanical joint cast or ductile iron pipe, asbestos-cement pressure pipe, prestressed concrete pipe, or PVC pipe equivalent to water main standards of construction. The drain or sewer shall be pressure tested to the maximum expected surcharge head before backfilling.

3.7 VERTICAL SEPARATION – WATER MAINS AND SEWERS

- A. A water main shall be separated from a sewer so that its invert is a minimum of 18 inches above the crown of the drain or sewer whenever water mains cross storm sewers, sanitary sewers or sewer service connections. The vertical separation shall be maintained for that portion of the water main located within ten feet horizontally of any sewer or drain crossed. A length of water main pipe shall be centered over the sewer to be crossed with joints equidistant from the sewer or drain.
- B. Both the water main and sewer shall be constructed of slip-on mechanical joint cast or ductile iron pipe, asbestos-cement pressure pipe, prestressed concrete pipe, or PVC pipe equivalent to water main standards of construction when:
 - 1. It is impossible to obtain the proper vertical separation as described in (1) above;
or
 - 2. The water main passes under a sewer or drain.
- C. A vertical separation of 18 inches between the invert of the sewer or drain and the crown of the water main shall be maintained where a water main crosses under a sewer. Support the sewer or drain lines to prevent settling and breaking the water main, as shown on the plans or as approved by the Construction Manager.
- D. Construction shall extend on each side of the crossing until the perpendicular distance from the water main to the sewer or drain line is at least ten feet.

END SECTION 33 40 00

SECTION 33 49 00 – STORM DRAINAGE STRUCTURES

PART 1 – GENERAL

1.1 WORK INCLUDES

- A. New precast storm sewer inlets and manholes with concrete tops and metal frames, lids or grates and accessories.
- B. Connection of new storm sewer pipe to existing inlet or manhole structure.
- C. Adjust existing manholes, inlets, valve boxes and meter vaults as required by the utility company or the Engineer.
- D. New precast concrete flared end sections and headwalls.

1.2 RELATED WORK

- A. Specified elsewhere:
 - 1. Section 31 23 16 – Excavation
 - 2. Section 33 40 00 – Storm Drainage Utilities

1.3 REFERENCES. Specified references, or cited portions thereof, current at date of bidding documents unless otherwise noted, govern the work.

- A. Missouri Department of Transportation (MoDOT): Standard Specifications for Highway Construction, including all addenda.
- B. Missouri Department of Natural Resources.
- C. Applicable MoDOT Highway Standards – Attached at end of this Section.

1.4 REGULATORY REQUIREMENTS

- A. Conform to the applicable portions of Section 731, 732 and 614 of the Missouri Department of Transportation (MoDOT): Standard Specifications for Highway Construction, including all Supplemental Specifications and Recurring Special Provisions.

PART 2 – PRODUCTS

2.1 PRECAST MANHOLE SECTIONS, STEPS, FRAMES AND LIDS

- A. The Contractor shall be required to submit shop drawings of each structure for approval in accordance with these documents, prior to fabricating or delivering any manholes.
- B. Manhole and inlet sections, castings and accessories shall conform to Section 614 of MoDOT's Standard Specifications, MoDOT's Highway standards and the project details and drawings included with the contract documents.
- C. Connections for storm sewer pipes shall be grouted in place with non-shrink grout material.
- D. Joints between precast manhole sections and under the casting frame shall be watertight and sealed by means of preformed butyl resin rope or by O-ring rubber gasket. Seal material shall not shrink, harden or oxidize with age. Installation shall be according to manufacturer's recommendations and as shown on the drawings.

- E. The Contractor shall adjust the manhole or inlet casting to the final ground line as shown on the plans or as directed by the Engineer in the field. Concrete "adjustment rings" having the same inside diameter as the casting may be used to raise the casting up to a maximum of 6".

PART 3 – EXECUTION

3.1 COORDINATION

- A. Schedule work and notify all crafts in time so that provisions for their work can be made without delaying the project.

3.2 INSTALLATION

- A. Excavation

In order to permit the joints to be mortared properly and also to permit proper compaction of the backfill material, the excavation shall be made to a diameter of at least two feet greater than the outside diameter of the structure.

- B. Subbase Preparation

Adequate foundation for manhole structures shall be obtained by removal and replacement of unsuitable material with well-graded granular material, by tightening with coarse ballast rock, or by such other means provided for foundation preparation of the connected sewers.

- C. Manhole Base Installation (Precast Base)

A well-graded granular bedding course conforming to the requirements for aggregate for trench backfill (Section 31 23 23), not less than four inches in thickness and extending to the limits of the excavation, shall be firmly tamped and made smooth and level to assure uniform contact and support of the precast element. A precise base section shall be carefully placed on the prepared bedding so as to be fully and uniformly supported in true alignment and making sure that all entering pipes can be inserted on proper grade.

D. Precast Manholes

1. Precast manholes may be constructed with a precast base section or a monolithic base structure as specified. Precast sections shall be placed and aligned to provide vertical sides and vertical alignment of the ladder runs. The completed manhole shall be rigid, true to dimensions and shall be watertight.
2. All lift holes in precast elements shall be completely filled with an approved bitumastic material. All joints between precast elements on sanitary sewer manholes shall be made with an o-ring rubber or neoprene gasket.

E. Construction Detail

1. Inlet and Outlet Pipes. Pipe or tile placed in the masonry for inlet or outlet connections shall extend through the wall and beyond the outside surface of the wall a sufficient distance to allow for connections, and the masonry shall be carefully constructed around them so as to prevent leakage along the outer surfaces. Special care shall be taken to see that the openings through which pipes enter the structure are completely sealed by use of a nonshrink grout.
2. Placing Castings. Casting adjustments of less than two inches shall be with mortar. The mortar shall be mixed in proportion of one part cement to three parts sand, by volume, based on dry materials. Castings shall be set accurately to the finished elevation so that no subsequent adjustment will be necessary. Castings shall be sealed to concrete sections with bitumastic material.
3. Manhole Inverts. Construct manhole flow channels of concrete or sewer pipe, which shall be of semicircular section conforming to the inside diameter changes in size and grade gradually, and changes in direction shall be by true curves. Provide channels for all connecting sewers to each manhole and benching shown on the drawings.

F. Backfill

The space between the sides of the excavation and the outer surfaces of the manhole shall be backfilled with aggregate for trench backfill when the manhole is in a pavement or when the nearest point of the excavation for the manhole falls within two feet of the paved edge.

G. Cleaning

All newly constructed inlets and manholes and any existing structures modified shall be cleaned of all accumulation of silt, debris or foreign matter of any kind and shall be free of such accumulations at the time of final inspection.

END OF SECTION 33 49 00

SECTION 34 41 16 – TRAFFIC CONTROL EQUIPMENT

PART 1 – GENERAL

1.1 WORK INCLUDES

- A. Layout, installation, maintenance and removal of temporary traffic control devices to prevent users of the off-site roadways and pedestrian-ways from entering the construction areas, and to direct them around the work zone.
- B. Layout, furnish and install permanent signs as shown in the plans.
- C. Remove, store and reinstall existing signs as shown in the plans or required by construction.

1.2 RELATED WORK (RESERVED)

1.3 REGULATORY REQUIREMENTS

- A. Conform to applicable portions of the Missouri Department of Transportation (MoDOT): Standard Specifications for Highway.
- B. Conform to the MoDOT Highway Standards included in the project details of these contract documents.
- C. Conform to the Manual on Uniform Traffic Control Devices.

1.4 SUBMITTALS

- A. Contractor to submit shop drawings prior to ordering and manufacturing any permanent signs.

PART 2 – PRODUCTS

2.1 TRAFFIC CONTROL DEVICES

- A. Temporary Traffic Control Devices: As specified per MoDOT requirements.
- B. Sign Panels: Furnish signs of the type, color and size shown in the plans or approved by the Owner, in accordance with MoDOT Standard Specifications, the Manual on Uniform Traffic Control Devices and the manufacturer's instructions.
- C. Posts: Furnish 2" square black powder coated telescoping tube steel posts with galvanized sign-mounting hardware for each sign.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Verify existing conditions. Field verify underground utilities prior to sign installation. Primary utilities of concern of shallow depths are irrigation, electric, telephone, cable and gas.
- B. Evaluate placement of traffic control devices in addition to the devices shown on the plans.
- C. Consider flow of traffic adjacent to site.
- D. Obtain required street and/or sidewalk closure permits from City.
- E. Provide Owner & City with 72 hours' notice prior to initiating traffic control.
- F. Verify sign locations will not conflict with landscaping or other obstructions.
- G. Cost related to repair damaged surface and subsurface facilities shall be paid for by the Contractor at no additional expense to the Owner.

3.2 INSTALLATION

- A. Implement traffic control devices to promote flow of traffic.
- B. Ensure traffic control devices are visible at night.
- C. Install signs as shown in the plans.

3.3 MAINTENANCE

- A. Correct traffic control devices that fail or are shifted by traffic.
- B. Adjust traffic control devices to respond to changes in traffic patterns and flow.

3.4 REMOVAL

- A. Upon final completion of the project, remove all traffic control devices.

END SECTION 34 41 16